STUDY GUIDE/WORKBOOK
J6ASP3E151 029 -1 thru 10

Technical Training

EXPORTABLE

DOD EPA UNIVERSAL

CFC/HCFC CERTIFICATION PROGRAM

January 2000

782d TRAINING GROUP
366th Training Squadron
(Civil Engineering Training)
Sheppard Air Force Base, Texas

TABLE OF CONTENTS STUDY/GUIDE/WORKBOOK J6ASP3E151 029

Supersedes All Study Guide/Workbooks J2ASR3E151 029 Prior to November 1995.
All previous Study Guides/Workbooks are obsolete for testing purposes.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460 September 26, 1995
OFFICE OF
AIR AND RADIATION

Dear Ladies and Gentlemen

Enclosed please find an updated summary of the Section 608 Refrigerant Recycling Rule. This summary reflects the amendments to the Rule that have been published over the past two and a half years, clarifying who needs to be certified as a technician and referring to more up-to-date industry standards (e.g., ARI 700-1993). In addition, the summary contains more information on how to obtain certified recovery and recycling equipment and on how to comply with the leak repair requirements. I believe that your members and/or readers may find the updated summary of interest. To obtain copies, they may call the Stratospheric Ozone Hotline at 1-800-296-1996.

Sincerely,

SIGNED

Deborah Ottinger
Stratospheric Protection Division

____366 TRS/TSIM
25 October 1995
727 MISSILE ROAD
SHEPPARD AFB TX 76311-2254

THIS SUMMARY IS AN UPDATE CONCERNING THE LATEST REVISIONS FOR SECTION 608 OF THE CLEAN AIR ACT, 1990.

BEFORE USING THE EPA HOT LINE TO FIND ANSWERS TO ANY QUESTIONS THAT YOU MAY HAVE, SEE PAGE 1, “COURSE CONTENT AND GOALS” AND PAGE 3 OF THIS BOOK “YOUR RESPONSIBILITIES”, USING THIS INFORMATION YOU SHOULD BE ABLE TO GET ANSWERS FROM THE AIR FORCE / YOUR BRANCH OF SERVICE / DEPARTMENT WITHOUT GOING TO THE EPA.

THE SUBJECTS IN THIS AUGUST 1995 REVISION WILL BE SUBJECT FOR TESTING WHEN THE NEW UPDATED AND REVISED CERTIFICATION TESTS ARE IMPLEMENTED IN THE WINTER OF 1995/1996. YOUR TESTING CENTER WILL ADVISE YOU WHEN THE NEW TESTS ARE BEING USED.

SIGNED
JERRY J FLESCH GS-11 DAF
EPA/DoD /CertificationProgram Director

Recycled/Recyclable Printed with Vegetable Oil Based Inks on 100%; Recycled Paper (40%)

United States	Office of Air and Radiation	August 1995
Environmental	Stratospheric Protection	Rev.1
Protection Agency	Division (6205-J)	EPA 430-F-95-117

FINAL RULE SUMMARY: COMPLYING WITH THE SECTlON 608 REFRIGERANT RECYCLING RULE

Introduction

This fact sheet provides an overview of the refrigerant recycling requirements of Section 608 of the Clean Air Act, 1990, as amended (CAA), including final regulations published on May 14, 1993 (:58 FR 28660), August 19, 1994 (.59 FR 42950), and November 9, 1994 (59 FR 55912). The fact sheet also describes the prohibition on venting that became effective on July 1, 1992.

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Overview

Under Section 608 of the CAA, EPA has established regulations that:

* Require service practices that maximize recycling of ozone-depleting compounds (both chlorofluorocarbons [CFCs] and hydorofluorocarbons [HCFCs] and their blends) during the servicing and disposal of air-conditioning and refrigeration equipment
* Set certification requirements for ***recycling*** and ***recovery equipment, technicians*** and ***reclaimer****s* (see pg. 10 for definitions for italicized words).
* Restrict the sale of refrigerant to certified technicians.
* Require persons servicing or disposing of air-conditioning and refrigeration equipment to certify to EPA that they have acquired recycling or recovery equipment and are complying with the requirements of the rule.
* .Require the repair of substantial leaks in air-conditioning and refrigeration equipment with a charge of greater than 50 pounds.
* Establish safe disposal requirements to ensure removal of refrigerants from goods that enter the waste stream with the charge intact (e.g., motor vehicle air conditioners, home refrigerators, and room air conditioners).

The Prohibition on Venting

Effective July 1, 1992, Section 608 of the Act prohibits individuals from knowingly venting ozone-depleting compounds used as refrigerants into the atmosphere while maintaining, servicing, repairing, or disposing of air-conditioning or refrigeration equipment (appliances). Only four types of releases are permitted under the prohibition:

1. "De minimis" quantities of refrigerant released in the course of making good faith attempts to recapture and recycle or safely dispose of refrigerant.

2. Refrigerants emitted in the course of normal operation of air-conditioning and refrigeration equipment (as opposed to .during the maintenance servicing, repair, or disposal of this equipment) such as from mechanical purging and leaks. However, EPA requires the repair of leaks above a certain size in large equipment (see p. 5).

3. Releases of CFCs or HCFCs <u>that are not used as refrigerants</u>. For instance mixtures of nitrogen and R-22 that are used as holding charges or as leak test gases may be released, because in these cases, the ozone-depleting compound is not used as a refrigerant. However, a technician may not avoid recovering refrigerant by adding nitrogen to a charged system; before nitrogen is added, the system must be evacuated to the appropriate level in Table 1. Otherwise the CFC or CFC vented along with the nitrogen will be considered a refrigerant. Similarly, <u>pure</u> CFCs or HCFCs released from appliances will be presumed to be refrigerants, and their release will be considered a violation of the prohibition on venting.

4. Small releases of refrigerant that result from purging hoses or from connecting or disconnecting hoses to charge or service appliances will not be considered violations of the prohibition on venting. However, recovery and recycling equipment manufactured after November 15, 1993, must be equipped with low-loss fittings. e

Regulatory Requirements

Service Practice Requirements

1. Evacuation Requirements. Since July 13, 1993, technicians have been required to evacuate air-conditioning and refrigeration equipment to established vacuum levels when *opening*, the equipment. If the technician's recovery or recycling equipment was manufactured any time before November 15, 1993, the air-conditioning and refrigeration equipment must be evacuated to the levels described in the first column of Table 1. If the technician's recovery or recycling equipment was manufactured on or after November 15, 1993, the air-conditioning and refrigeration equipment must be evacuated to the levels described in the second column of Table 1, and the recovery or recycling equipment must have been certified by an EPA-approved equipment testing organization (see *Equipment Certification*, below). Persons who simply add refrigerant to (top-off) appliances are not required to evacuate the systems.

Technicians repairing .*small appliances*, such as household refrigerators, window air

TABLE 1
REQUIRED LEVELS OF EVACUATION FOR APPLIANCES
EXCEPT FOR SMALL APPLIANCES, MVAC, AND MVAC LIKE APPLIANCES

Type of Appliance	Inches of Mercury Vacuum* Using Equipment Manufactured: Before Nov 15,1993	On or after 15 Nov 1993
HCFC-22 appliance **normally containing less than 200 pounds of refrigerant	0	0
HCFC-22 appliance ** normally containing 200 pounds or more of refrigerant	4	10
Other high-pressure appliance **normally containing less than 200 pounds of refrigerant (CFC-12 -500 -502, -114)	4	10
Other high-pressure appliance normally containing 200 pounds or more of refrigerant (CFC-12, -500, -502, -114)	4	15
Very High Pressure Appliance (CFC-13, -503)	0	0
Low-Pressure Appliance (CFC-11, HCFC-123)	25	25mm HG absolute

* relative to standard atmospheric pressure of 29.9” Hg. **Or isolated component of such an appliance

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Conditioners, and water coolers, must recover:

* 80 percent of the refrigerant when
  - the technician uses recovery or recycling equipment manufactured before November I5, 1993, <u>or</u>
  - the Compressor in the appliance is <u>not</u> operating;

OR

* 90 percent of the refrigerant when
  - the technician uses recovery or recycling equipment manufactured after November 15, <u>and</u>

  - the compressor in the appliance <u>is</u> operating

In order to ensure that they are recovering the correct percentage of refrigerant, technicians must use the recovery equipment according to the directions of its manufacturer. Technicians may also satisfy recovery requirements by evacuating the small appliance to four inches of mercury vacuum.

2. *Exceptions to Evacuation Requirements*.. EPA has established limited exceptions to its evacuation requirements for 1) repairs to leaky equipment and 2) repairs that are not *major* and that are not followed by an evacuation of the equipment to the environment.

If, due to leaks, evacuation to the levels in Table I is not attainable, or would substantially contaminate the refrigerant being recovered, persons opening the appliance must:

• isolate leaking from non-leaking components wherever possible;

• evacuate non-leaking components to the levels in. Table l and

• evacuate leaking components to the lowest level that can be attained without substantially contaminating the refrigerant. This level cannot exceed 0 psig

If evacuation of the equipment to the environment is not to be performed when repairs are complete, and if the repair is not major, then the appliance must:

• be evacuated to at least 0 psig before it is opened if it is a high- or very high pressure appliance; or

• be pressurized to 0 psig before it is opened if it is a low-pressure appliance. Methods that require subsequent purging (e.g., nitrogen) cannot be used except with appliances containing R- 113.

3. *Reclamation Requirement*. EPA has also established that refrigerant recovered and/or recycled can be returned to the same system or other systems owned by the same person without restriction. If refrigerant changes ownership, however, that refrigerant must be reclaimed (i.e., cleaned to the ARI 700-1993 standard of purity and chemically analyzed to verify that it meets this standard) unless the refrigerant was used only in a motor vehicle air conditioner (MVAC) or MVAC-like appliance and will be used in the same type of appliance. (Refrigerant used in MVACs and MVAC like appliances is subject to the purity requirements of the MVAC regulations at 40 CFR Part 82 Subpart B.)

Equipment Certification

The Agency has established a certification program for recovery and recycling equipment. Under the program, EPA requires that equipment manufactured on or after November 15, 1993, be tested by an EPA-approved testing organization to ensure that it meets EPA requirements. Recycling and recovery equipment intended for use with air-conditioning and refrigeration equipment besides small appliances must be tested under the ARI 740-1993 test protocol, which is included in the final rule as Appendix B. Recovery equipment intended for use with small appliances must be tested under either the ARI 740-1993 protocol or Appendix C of the final rule.

The Agency requires recovery efficiency standards that vary depending on the size and type of air-conditioning or refrigeration equipment being serviced. For recovery and recycling equipment intended for use with air-conditioning and refrigeration equipment besides small appliances, these standards are the same as those in the second column of Table 1. Recovery equipment intended for use with small appliances must be able to recover 90 percent of the refrigerant in the small appliance when the small appliance compressor is operating and 80 percent of the refrigerant in the small appliance when the compressor is not operating.

EPA has approved both the Air-Conditioning and Refrigeration Institute (ARI) and Underwriters Laboratories (UL) to certify recycling and recovery equipment.

Certified equipment can be identified by a label reading: “This equipment has been certified by ARI/UL to meet EPA’s minimum requirements for recycling and/ or recovery equipment intended for use with [appropriate category of appliance-e.g., small appliances, HCFC appliances containing less than 200 pounds of refrigerant, all high-pressure appliances, etc.].” Lists of certified equipment may be obtained by Contacting ARI at 703-524-8800 and UL at 708-262-8800 ext. 42371.

Equipment Grandfathering

Equipment manufactured before November 15, 1993, including home-made equipment, may be grandfathered if it meets the standards in the first column of Table 1. Third-party testing is not required for equipment manufactured before November 15, 1993, but equipment manufactured on or after that date, including home-made equipment, must be tested by a third-party (see *Equipment Certification* above).

Refrigerant Leaks

Owners of equipment with charges of greater than 50 pounds are required to repair leaks in the equipment when those leaks together would result in the loss of more than a certain percentage of the equipment’s charge over a year. For the commercial and industrial process refrigeration sectors, leaks must be repaired when the appliance leaks at a rate that would release 35 percent or more of the charge over a year. For all other sectors, including comfort cooling, leaks must be repaired when the appliance leaks at a rate that would release 15 percent or more of the charge over a year.

The trigger for repair requirements is the current leak rate rather than the total quantity of refrigerant lost. For instance, owners of a commercial refrigeration system containing 100 pounds of charge must repair leaks if they find that the system has lost 10 pounds of charge over the past month; although 10 pounds represents only 10 percent of the system charge in this case, a leak rate of 10 pounds per month would result in the release of over 100 percent of the charge over the year. To track leak rates, owners of air-conditioning and refrigeration equipment with more than 50 pounds of charge must keep records of the quantity of refrigerant added to their equipment during servicing and maintenance procedures.

Owners are required to repair leaks within 30 days of discovery. This requirement is waived if, within 30 days of discovery, owners develop a one-year retrofit or retirement plan for the leaking equipment. Owners of industrial process refrigeration equipment may qualify for additional time under certain circumstances. For example, if an industrial process shutdown is required to repair a leak, owners have 120 days to repair the leak. Owners of leaky industrial process refrigeration equipment should see the Compliance Assistance Guidance Document for Leak Repair for additional information concerning time extensions and pertinent recordkeeping and reporting requirements.

Technician Certification

EPA has established a technician certification program for persons (“technicians”) who perform maintenance, service, repair, or disposal that could be reasonably expected to release refrigerants into the atmosphere.

The definition of “technician specifically includes and excludes certain activities as follows:

Included

- attaching and detaching hoses and gauges to and from the appliance to measure pressure within the appliance;
- adding refrigerant to or removing refrigerant from the appliance
- any other activity that violates the integrity of the *refrigerant circuit* while there is refrigerant in the appliance.

Excluded:

- activities that are not reasonably expected to violate the integrity of the refrigerant circuit, such as painting the appliance, rewiring an external electrical circuit, replacing insulation on a length of pipe, or tightening nuts and bolts on the appliance;
- maintenance, service, repair, or disposal of appliances that have already been evacuated in accordance with EPA requirements, unless the maintenance consists of adding refrigerant to the appliance;
- servicing motor vehicle air conditioners (MVACs), which are subject to the certification requirements of the MVAC refrigerant recycling rule; and,
- disposing of MVACs, MVAC-like appliances, and small appliances.

In addition, apprentice as defined On page 10 are exempt from certification requirements provided the apprentice is closely and continually supervised by a certified technician.

The Agency has developed four types of certification:

* For servicing small appliances (Type I).
* For servicing or disposing of highs or very high-pressure appliances, except small appliances and MVACs (Type II).
* For servicing or disposing of low-pressure appliances (Type III)
* For servicing all types of equipment (Universal).

Technicians are required to pass an EPA-approved test given by an EPA-approved certifying organization to become certified under the mandatory program. The Stratospheric Ozone Hotline distributes lists of approved testing organizations.

Refrigerant Sales Restrictions

Under Section-609 of the Clean Air Act, sales of CFC-12 in containers smaller than 20 pounds are restricted solely to technicians certified under EPA’s motor vehicle air Conditioning regulations. Persons servicing appliances other than motor vehicle air conditioners may still buy containers of CFC-12 larger than 20 pounds.

Effective November 14, 1994, the sale of refrigerant in any size container is restricted to technicians certified either under the program described in *Technician Certification* above or under EPA’s motor vehicle air conditioning regulations. The sales restriction covers refrigerant contained in bulk containers (cylinders or drums) and pre-charged parts.

The restriction excludes refrigerant contained in refrigerators or air conditioners with fully assembled refrigerant circuits (such as household refrigerators, window air conditioners, and packaged air conditioners), pure HFC refrigerants, and CFCs or HCFCs that are not intended for use as refrigerants. In addition, a restriction on sale of pre-charged split systems has been stayed (suspended) while EPA reconsiders this provision.

Certification by Owners of Recycling and Recovery Equipment

EPA requires that persons servicing or disposing of air-conditioning and refrigeration equipment certify to the appropriate EPA Regional Office that they have acquired (built, bought, or leased) recovery or recycling equipment and that they are complying with the applicable requirements of this rule. This certification must be signed by the owner of the equipment or another responsible officer and sent to the appropriate EPA Regional Office. A sample form for this certification is attached. Although owners of recycling and recovery equipment are required to list the number of trucks based at their shops, they do not need to have a piece of recycling or recovery equipment for every truck. Owners do not have to send in a new form each time they add recycling or recovery equipment to their inventory.

Reclaimer Certification

Reclaimers are required to return refrigerant to the purity level specified in ARI Standard 700-1993 (an industry-set purity standard) and to verify this purity using the laboratory protocol set forth in the same standard. In addition, reclaimers must release no more than 1.5 percent of the refrigerant during the reclamation process and must dispose of wastes properly. Reclaimers must certify to the Section 608 Recycling Program Manager at EPA headquarters that they are complying with these requirements and that the information given is true and correct. Certification must also include the name and address of the reclaimer and a list of equipment used to reprocess and to analyze the refrigerant.

EPA encourages reclaimers to participate in third-party reclaimer certification programs, such as that operated by the Air Conditioning and Refrigeration Institute (ARI). Third-party certification can enhance the attractiveness of a reclaimer’s product by providing an objective assessment of its purity.

MVAC-like Appliances

Some of the air conditioners that are covered by this rule are identical to motor vehicle air conditioners (MVACs), but they are not covered by the MVAC refrigerant recycling rule (40 CFR Part 82, Subpart B) because they are used in vehicles that are not defined as “motor vehicles.” These air conditioners include many systems used in construction equipment, farm vehicles, boats, and airplanes. Like MVACs in cars and trucks, these air conditioners typically contain two or three pounds of CFC-12 and use open-drive compressors to cool the passenger compartments of vehicles. (Vehicle air conditioners utilizing HCFC-22 are not included in this group and are therefore subject to the requirements outlined above for HCFC-22 equipment.) EPA is defining these air conditioners as “MVAC-like appliances” and is applying the MVAC rule’s requirements for the certification and use of recycling and recovery equipment to them.

That is, technicians servicing MVAC-like appliances must “properly use” recycling or recovery equipment that has been certified to meet the standards in Appendix A to 40 CFR Part 82, Subpart B. In addition EPA is allowing technicians who service MVAC like appliances to be certified by a certification program approved under the MVAC rule, if they wish.

Safe Disposal Requirements

Under EPA’s rule, equipment that is typically dismantled on-site before disposal (e.g., retail food refrigeration, central residential air conditioning, chillers, and industrial process refrigeration) has to have the refrigerant recovered in accordance with EPA’s requirements for servicing. However, equipment that typically enters the waste stream with the charge intact (e.g., motor vehicle air conditioners, household refrigerators and freezers, and room air conditioners) is subject to special safe disposal requirements.

Under these requirements, the final person in the disposal chain (e.g., a scrap metal recycler or landfill owner) is responsible for ensuring that refrigerant is recovered from equipment before the final disposal of the equipment. However, persons “upstream” can remove the refrigerant and provide documentation of its removal to the final person if this is more cost-effective.

The equipment used to recover refrigerant from appliances prior to their final disposal must meet the same performance standards as equipment used prior to servicing, but it does not need to be tested by a laboratory. This means that self-built equipment is allowed as long as it meets the performance requirements. For MVACs and MVAC-like appliances, the performance requirement is 102 mm of mercury vacuum and for small appliances, the recovery equipment performance requirements are 90 percent efficiency when the appliance compressor is operational, and 80 percent efficiency when the appliance compressor is not operational.
Technician certification is not required for individuals removing refrigerant from appliances in the waste stream.

The safe disposal requirements went into effect on July 13, 1993. Equipment must registered or certified with the Agency. A sample form is attached.

Major Recordkeeping Requirements

Technicians servicing appliances that contain 50 or more pounds of refrigerant must provide the owner with an invoice that indicates the amount of refrigerant added to the appliance. Technicians must also keep a copy of their proof of certification at their place of business.

Owners of appliances that contain 50 or more pounds of refrigerant must keep servicing records documenting the date and type of service, as well as the quantity of refrigerant added.

Wholesalers who sell CFC and HCFC refrigerants must retain invoices that indicate the name of the purchaser, the date of sale, and the quantity of refrigerant purchased.

Reclaimers must maintain records of the names and addresses of persons sending them material for reclamation and the quantity of material sent to them for reclamation. This information must be maintained on a transactional basis. Within 30 days of the end of the calendar year, reclaimers must report to EPA the total quantity of material sent to them that year for reclamation, the mass of refrigerant reclaimed that year, and the mass of waste products generated that year.

Hazardous Waste Disposal

If refrigerants are recycled or reclaimed, they are not considered hazardous under federal law. In addition, used oils contaminated with CFCs are not hazardous on the condition that:

* They are not mixed with other waste.

* They are subjected to CFC recycling or reclamation.

* They are not mixed with used oils from other sources.

Used oils that contain CFCs after the CFC reclamation procedure, however, are subject to specification limits for used oil fuels if these oils are destined for burning. Individuals with questions regarding the proper handling of these materials should contact EPA's RCRA Hotline at 800-4249346 or 703-920-9810.

Enforcement

EPA is performing random inspections, responding to tips, and pursuing potential cases against violators. Under the Act, EPA is authorized to assess fines of up to $25,000 per day for any violation of these regulations.

Planning and Acting for the Future

Observing the refrigerant recycling regulations for Section 608 is essential in order to conserve existing stocks of refrigerants, as well as to comply with Clean Air Act requirements. However, owners of equipment that contains CFC refrigerants should look beyond the immediate need to maintain existing equipment in working order. **EPA urges equipment owners to act now and prepare for the phaseout of CFC production and import, scheduled for January 1, 1996.** Owners are advised to begin planning for conversion or replacement of existing equipment with equipment that uses alternative refrigerants.

To assist owners, suppliers, technicians and others involved in comfort chiller and commercial refrigeration management, EPA has published a series of short fact sheets and expects to produce additional material. Copies of material produced by the EPA Stratospheric Protection Division are available from the Stratospheric Ozone Information Hotline (see Hotline number below).

For Further Information

For further information concerning regulations related to stratospheric ozone protection, please call the Stratospheric Ozone Information Hotline: 800-296-1996. The hotline is open between 10:00 AM and 4:00 PM, Eastern'time.

DEFINITIONS

Appliance Any device which contains and uses a class I (CFC) or class II (HCFC) substance as a refrigerant and which is used for household or commercial purposes, including any air conditioner, refrigerator, chiller, or freezer. EPA interprets this definition to include all air-conditioning and refrigeration equipment except that designed and used exclusively for military purposes.

Apprentice Any person who is currently registered as an apprentice in service, maintenance, repair, or disposal of appliances with the U.S. Department of Labor's Bureau of Apprenticeship and Training (or a State Apprenticeship Council recognized by the Bureau of Apprenticeship and Training).
Major maintenance, service, or repair Maintenance, service, or repair that involves removal of the appliance compressor, condenser, evaporator, or auxiliary heat exchanger coil.

MVAC-like appliance Mechanical vapor compression, open-drive compressor appliances used to cool the driver's or passenger's compartment of a non-road vehicle, including agricultural and construction vehicles. This definition excludes appliances using HCFC-22.

Opening Any service, maintenance, or repair on an appliance that would release class I or class 11 refrigerant from the appliance to the atmosphere unless the refrigerant were recovered previously from the appliance. Connecting and disconnecting hoses and gauges to and from the appliance to measure pressures within the appliance and to add refrigerant to or recover refrigerant from the appliance shall not be considered "opening."

Reclaim To reprocess refrigerant to at least the purity specified in the ARI Standard 7001993, Specifications for Fluorocarbon Refrigerants, and to verify this purity using the analytical methodology prescribed in the Standard.

Recover To remove refrigerant in any condition from an appliance and store it in an external container without necessarily testing or processing it in any way.

Recycle To extract refrigerant from an appliance and clean refrigerant for reuse without meeting all of the requirements for reclamation. In general, recycled refrigerant is refrigerant that is cleaned using oil separation and single or multiple passes through devices, such as replaceable core filter-dryers, which reduce moisture, acidity, and particulate matter.

Refrigerant circuit The parts of an appliance that are normally connected to each other for are separated only by internal valves) and are designed to contain refrigerant.

Small appliance Any of the following products that are fully manufactured, charged, and hermetically sealed in a factory with five pounds or less of refrigerant: refrigerators and freezers designed for home use, room air conditioners (including window air conditioners and packaged terminal air conditioners), packaged terminal heat pumps, dehumidifiers, under-the-counter ice makers, vending machines, and drinking water coolers.

Technician Any person who performs maintenance, service, or repair that could reasonably be expected to release class I {CFC) or class 11 (HCFC) substances from appliances, except for MVACs, into the atmosphere. Technician also means any person performing disposal of appliances, except for small appliances, MVACs, and MVAC-like appliances, that could be reasonably expected to release class I or class 11 refrigerants from appliances into the atmosphere. (See page 6 for a more detailed discussion.)

OMB # 2060-0256
Expiration Date: 5/96

**THE UNITED STATES ENVIRONMENTAL PROTECTION AGENCY (EPA)
REFRIGERANT RECOVERY OR RECYCLING DEVICE
ACQUISITION CERTIFICATION FORM**

EPA regulations require establishments that service or dispose of refrigeration or air conditioning equipment to Certify by August 12, 1993 that they have acquired recovery or recycling devices that meet EPA standards for such devices. To Certify that you have acquired equipment, please complete this form according to the instructions and **mail it to the appropriate EPA Regional Office. BOTH THE INSTRUCTIONS AND MAILING ADDRESSES CAN BE FOUND ON THE REVERSE SIDE OF THIS FORM.**

PART 1: ESTABLISHMENT INFORMATION

Name Of Establishment ______________________ Street ______________________

(Area Code) Telephone Number ______________________ City ____________ State ______ Zip Code ________

Number Of Service Vehicles Based at Establishment ______________ County ______________________

PART 2: REGULATORY CLASSIFICATION

Identify the type of work performed by the establishment. Check all boxes that apply.

________ Type A -Service small appliances
________ Type B -Service refrigeration or air car air conditioning equipment other than small appliances
________ Type C -Dispose of small appliances
________ Type D -Dispose of refrigeration or air conditioning equipment other than small appliances

PART 3: DEVICE IDENTIFICATION

	Name of Device(s) Manufacturer	Model Number	Year	Serial Number (if any)	Check Box if Self Contained
1.					
2.					
3.					
4.					
5.					
6.					
7.					

4: CERTIFICATION SIGNATURE

I certify that the establishment in Part 1 has acquired the refrigerant recovery or recycling device(s) listed in Part 2, that the establishment is complying with Section 608 regulations, and that the information given is true and correct.

Signature of Owner/Responsible Officer / Date / Name (Please Print) / Title

____________________________/_______/ ______________________/________________

Public reporting burden for this collection of information is estimated to vary from 20 minutes to 60 minutes with an average of 40 minutes per response including for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing the collection of information. Send comments regarding ONLY the burden estimates or any other aspects of this collection of information, including suggestions for reducing this burden to Chief Information Branch: EPA, 401 M ST |SW (PM-223Y) Washington DC 20503 marked Attention Desk Officer of EPA DO NOT SEND THIS FORM TO THE ABOVE ADDRESSES. ONLY SEND COMMENT TO THESE ADDRESSES

Instructions

Part 1: Please provide the name, address, and telephone number of the establishment where the refrigerant recovery or recycling device(s) is (are) located. Please complete one form for each location. State the number of vehicles based at this location that are used to transport technicians and equipment to and from service sites.

Part 2: Check the appropriate boxes for the type of work performed by technicians who are employees of the establishment. The term small appliance- refers to any of the following products that are fully manufactured, charged, and hermetically sealed in a factory with five pounds or less of refrigerant: refrigerators and freezers designed for home use, room air conditioners (including window air conditioners and packaged terminal air conditioners), packaged terminal heat pumps, dehumidifiers, under-the counter ice makers, vending machines, and drinking water coolers.

Part 3: For each recovery or recycling device acquired, please list the name of the manufacturer of the device, and (if applicable) its model number and serial number. If more than 7 devices have been acquired, please fill out an additional form and attach it to this one. Recovery devices that are self-contained should be listed first and should be identified by checking the box in the last column on the right. Self-contained recovery equipment means refrigerant recovery or recycling equipment that is capable of removing the refrigerant from an appliance without the assistance of components contained in the appliance. On the other hand, system-dependent recovery equipment means refrigerant recovery equipment that requires the assistance of components contained in an appliance to remove the refrigerant from the appliance. If the establishment has been listed as Type B and/or Type D in Part 2, then the first device listed in Part 3 must be a self-contained device and identified as such by checking the box in the last column on the right. If any of the devices are homemade, they should be identified by writing homemade- in the column provided for listing the name of the device manufacturer. Type A or Type B establishments can use homemade devices manufactured before November 15, 1993. Type C or Type D establishments can use homemade devices manufactured anytime. If, however, a Type C or Type D establishment is using homemade equipment manufactured after November 15, 1993, then it must not use these devices for service jobs.

Part 4: This form must be signed by either the owner of the establishment or another responsible officer. The person who signs is certifying that the establishment has acquired the equipment, that the establishment is complying with Section 608 regulations, and that the information provided is true and correct.

EPA Regional Offices

Send your form to the EPA office listed under the state or territory in which the establishment is located.

Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, Vermont
CM 608 Enforcement Contact: EPA Region I,
Mail Code APC, JFK Federal Building,
One Congress Street, Boston, MA 02203

New York, New Jersey, Puerto Rico, Virgin Islands
CM 608 Enforcement Contact: EPA Region II,
Jacob K. Javits Federal Building, Room 5000, 26
Federal Plaza, New York, NY 10278

Delaware, District of Columbia, Maryland, Pennsylvania, Virginia, West Virginia
CM 608 Enforcement Contact: EPA Region III
, Mail Code 3AT21, 841 Chestnut Building,
Philadelphia, PA 19107

Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, Tennessee
CM 608 Enforcement Contact: EPA Region IV,
Mail Code APT-AE, 345 Courtland Street, NE,
Atlanta, GA 30365

Illinois, Indiana, Michigan, Minnesota, Ohio, Wisconsin
CM 608 Enforcement Contact: EPA Region V,
Mail Code AT18J, 77 W. Jackson Blvd.,
Chicago, IL 60604

Arkansas, Louisiana, New Mexico, Oklahoma, Texas
CM 608 Enforcement Contact: EPA Region VI,
Mail Code 6T-EC, First Interstate Tower at Fountain Place,
1445 Ross Ave., Suite 1200,
Dallas TX 75202

Iowa, Kansas, Missouri, Nebraska
CM 608 Enforcement Contact: EPA Region VII,
Mail Code ARTX/ARBR,
726 Minnesota Ave.,
Kansas City, KS 66101

Colorado, Montana, North Dakota, South Dakota, Utah, Wyoming
CM 608 Enforcement Contact: EPA Region VIII
Mail Code 8AT-AP, 999 18th Street, Suite 500
Denver, CO 80202

American Samoa, Arizona, California, Guam, Hawaii, Nevada
CM 608 Enforcement Contact: EPA Region IX,
Mail Code A-3, 75 Hawthorne Street,
San Francisco, CA 94105

Alaska, Idaho, Oregon, Washington
CM 608 Enforcement Contact: EPA Region X,
Mail Code AT-082, 1200 Sixth Ave., Seattle, WA 98101

GLOSSARY OF TERMS

The following are terms used in this book. Some may or may not be the same as what you are use to. You must be familiar with them because they are the terms that the EPA uses.

ALKYLBENZENE - A lubricant artificially manufactured from propylene and benzine products. Most often used with HCFC ternary refrigerants.

APPLIANCE - Any device which contains and uses a class I or class II substance as a refrigerant and which is used for household or commercial purposes, including any air conditioner, refrigerator, chiller, or freezer.

APPROVED EQUIPMENT TESTING ORGANIZATION - Any organization which has applied for and received approval from the Administrator pursuant to FR 82.160.

ASPHYXIA - The loss of consciousness as the result of too little oxygen and too much carbon dioxide in the blood. Suffocation will cause asphyxia.

ATOM - The smallest unit or element of a compound.

AZEOTROPIC - The mixture of two refrigerants to form another refrigerant with a single boiling point.

BINARY - Something having two elements or parts.

BTU/HR - The amount of heat measured in BTUs per hour that can be added or removed from a substance. In refrigeration 1 TON of refrigeration effect is equal to 12,000 BTUs of heat removal from 1 pound of water in 1 hour.

CAA - The Clean Air Act of 15 November l990

CATARACTS - An eye disorder that can be caused by ultraviolet radiation.

CERTIFIED REFRIGERANT RECOVERY OR RECYCLING EQUIPMENT - Equipment certified by an approved equipment testing organization to meet the standards in FR 82.158 (b) or (d), equipment certified pursuant to FR 82.36(a), or equipment manufactured before November 15, 1993, that meets the standards in 82.158 (c), (e), or (g).

COMMERCIAL REFRIGERATION - For the purpose of 82.156(i), the refrigeration appliances utilized in the retail food and cold storage warehouse sectors. Retail food includes the refrigeration equipment found in supermarkets, convenience stores, restaurants and other food service establishments. Cold storage includes the equipment used to store meat, produce, dairy products, and other perishable goods. All of the equipment contains large refrigerant charges, typically over 75 pounds.

DE MINIMIS - Minute quantities of refrigerant released in the course of making good faith attempts of recapture and recycle or safe disposal of refrigerant.

DISPOSAL - The process leading to and including: (1) The discharge, deposit, dumping, or placing of any discarded appliance into or on any land or water. (2) The disassembly of any appliance for discharge, deposit, dumping, or placing of its discarded component parts into or on any land or water. (3) The disassembly of any appliance for reuse of its component parts.

DOT - The United States Department of Transportation, for example you may see DOT regulations or DOT forms.

ESTER OILS or LUBRICANTS - An organic compound lubricant made through a process of synthesis of salt reaction to acid. A lubricant that can be used with HFC refrigerant charged systems.

FRACTIONATION - Associated with ternary type refrigerants that are leaking from an appliance. Each one of the refrigerants will leak at a different rate.

GLOBAL WARMING - A slow or gradual rising of the earth temperatures that has been traced to the pollutants from CFCs, HCFCs, carbon dioxide and carbon monoxide reaching to the stratosphere. These pollutants absorb and then reflect infrared radiation back to earth thus causing the warming trend.

GRANDFATHERING - Civilian and government organizations that developed training and testing technicians prior to the implementation of mandatory certification program set up by the EPA. Those programs that were approved for grandfathering will notify those that were trained / tested if they will have to retest or sign certificates of additional training to be reissued valid certificates. This must be completed prior to 15 May 1995. (For those people that hold USAF or DOD Certificates those certificates are valid and do not have to be reissued.) The DOD program requested grandfathering for an extension and was granted the extension officially 13 Feb. 1995 at which time everyone must be certified by 15 May 1995. For those people that have USAF certificates, they may request a miniature (wallet size) DOD certificate by sending a copy of the wallet sized certificate to Sheppard and it will be replaced with the same certificate number.

HIGH-PRESSURE APPLIANCE - An appliance that uses a refrigerant with a boiling point between -50 and +10 degrees Centigrade at atmospheric pressure (29.9 inches of mercury). This definition includes but is not limited to appliances using refrigerants -12, -22, -114, -500, or -502.

HYDROCARBON - A compound that contains hydrogen and carbons, for example, hydrocarbon refrigerants.

HYGROSCOPIC - A compound that will have a high affinity (absorbs) to water, for example, salt to water.

INDUSTRIAL PROCESS REFRIGERATION - For the purposes of 82.156(i), complex customized appliances used in the chemical, pharmaceutical, petrochemical and manufacturing industries. This sector also includes industrial ice machines and ice rinks.

LOW-LOSS FITTINGS - Any device that is intended to establish a connection between hoses, appliances, or recovery or recycling machines and that is designed to close automatically or to be closed manually when disconnected, minimizing the release of refrigerant from hoses, appliances, and recovery or recycling machines.

LOW-PRESSURE APPLIANCE - An appliance that uses a refrigerant with a boiling point above 10 degrees Centigrade at atmospheric pressure (29.9 inches of mercury). This definition includes but is not limited to equipment utilizing refrigerants -11, -113, and -123.

MAJOR MAINTENANCE, SERVICE, OR REPAIR - Any maintenance, service, or repair involving the removal of any or all of the following appliance components: Compressor, condenser, evaporator, or auxiliary heat exchanger coil.

MISCIBLE - A mixable substance of any proportions.

MONTREAL PROTOCOL - In September of 1987 the United States and 22 other nations signed a protocol agreement to control the release of ozone depleting substances. The protocol also contains a clause that bans the import or export of products containing CFCs from those nations that did not sign the agreement.

MVAC (MOTOR VEHICLE AIR CONDITIONER) - Any appliance that is a motor vehicle air conditioner as defined in 40 CFR part 82, subpart B. Generally an open drive type compressor used to supply air conditioning cooling to cool the passenger compartment for on the road type of motor vehicles Persons servicing this type of equipment must be certified under the 609 Certification Program.

MVAC-LIKE APPLIANCE - Mechanical vapor compression, open drive but generally hermetic type compressor appliances used to cool the driver's or passenger's compartment of an non-road motor vehicle. This includes the air conditioning equipment found on agricultural or construction vehicles. This definition is not intended to cover appliances using HCFC-22 refrigerant.

OPENING AN APPLIANCE - Any service, maintenance, or repair on an appliance that could be reasonably expected (that would *) to release refrigerant from the appliance to the atmosphere unless the refrigerant were previously recovered from the appliance.

* OPENING AN APPLIANCE - Any service, maintenance, or repair on an appliance that would release class I or class II refrigerant from the appliance to the atmosphere unless the refrigerant were recovered previously from the appliance. Connecting hoses and gauges to and from the appliance to measure pressures within the appliance and to add refrigerant to or recover refrigerant from the appliance shall not be considered “opening”. (40 CFR Part 82, Nov 9 1994)

OZONE DEPLETION - A process that takes effect when CFC and HCFC refrigerants have reached the stratosphere and has been broken down by ultraviolet radiation separating the chlorine molecules from the refrigerants permitting the depletion of the ozone layer. This will permit the sun's dangerous ultraviolet rays to enter the earth's atmosphere.

ODP - Ozone depletion potential, a chart or scale that assigns the level or the ability of a substance to deplete the stratospheric ozone layer. For example, R-12 (CFC) has an ODP of 0.93, R-22 (HCFC) has an ODP of 0.05 while R 134a (HFC) has an ODP of 0.0.

PAGs (Polyalkylene glycol's) - A lubricant that will be used with HFC type refrigerants. PAG type lubricants will not mix with chlorine.

POLYOLESTERS - A synthetic lubricant to be used with HFC type refrigerants. It is not a new type lubricant and has been used in aircraft jet engines for years for lubrication.

PROCESS STUB - (Process Tube) - A length of tubing that provides access to the refrigerant inside a small appliance or room air conditioner and that can be resealed at the conclusion of repair or service. The process stub or tube will be found on most hermetic systems and can be installed on both the low and high side of the system. The tube is designed for soldering or clamping on some kind of access valve generally a schrader type valve. All Type I appliances now manufactured today are required to have a process tubes today.

RECLAIM (Refrigerant) - To reprocess refrigerant to at least the purity specified in the ARI Standard 700-1988, Specifications for Fluorocarbon Refrigerants (appendix A to 40 CFR part 82, subpart F) and to verify this purity using the analytical methodology prescribed in the ARI Standard 700-1988. In general, reclamation involves the use of processes or procedures available only at a reprocessing or manufacturing facility.

RECOVER (Refrigerant) - To remove refrigerant in any condition from an appliance without necessarily testing or processing it in any way.

RECOVERY EFFICIENCY - The percentage of refrigerant in an appliance that is recovered by a piece of recycling or recovery equipment.

RECYCLE (Refrigerant) - To extract refrigerant from an appliance and clean the refrigerant for reuse without meeting all of the requirements for reclamation. In general, recycled refrigerant is refrigerant that is cleaned using oil separation and single or multiple passes through devices, such as replaceable core filter-driers, which reduce moisture, acidity, and particulate matter. These procedures are usually implemented at the field job site.

SELF-CONTAINED RECOVERY EQUIPMENT - Refrigerant recovery or recycling equipment that is capable of removing the refrigerant from an appliance without the assistance of components contained in the appliance.

SERVICE APERTURE - A service valve required on all type II refrigeration and air conditioning appliances for servicing. It is generally a three way service valve on most larger systems with a gauge port (mid position), isolation (front position) closes off the compressor to the rest of the system, and a back position which closes off the gauge port on the valve. The service aperture will be found on both the high and low side of the compressor and on some system on or after the receiver. Some smaller systems may have a factory installed access valve (schrader valve) installed in the system rather than the three way service valve. New systems will have a schrader valve installed in the service port of the three way valve.

SKIN CANCER - Some types of this cancer can be traced directly to the depletion of the ozone protective layer permitting excessive amounts of ultraviolet (UV) radiation to come into direct contact with the skin.

SMALL APPLIANCE - Any of the following products that are fully manufactured, charged, and hermetically sealed in a factory with five (5) pounds or less of refrigerant: refrigerators and freezers designed for home use, room air conditioners which includes window air conditioners and ((PTACs)) packaged terminal air conditioners, packaged terminal heat pumps, dehumidifiers, under-the-counter ice makers, vending machines, and drinking water coolers.

SYSTEM-DEPENDENT RECOVERY EQUIPMENT - Refrigerant recovery equipment that requires the assistance of components contained in an appliance to remove the refrigerant from the appliance.

TECHNICIAN - Any person who performs maintenance, service, or repair that could reasonably be expected to release class I or class II substances from appliances into the atmosphere, including but not limited to installers, contractor employees, in-house service personnel, and in some cases, owners. Technician also means any person disposing of appliances except for small appliances.

TEMPERATURE GLIDE - A refrigerant made up of several refrigerants with several condensing and evaporative temperatures at one pressure. Temperature glide will be found in the ternary type refrigerants.

TERNARY - Something that has three parts or divisions. For example, a ternary refrigerant has three different refrigerants mixed to form one refrigerant.

TORRs - A unit of pressure 1/760 atmosphere (atmosphere = to 14.7 PSIA). A figure used in some fields for measuring closed systems pressures.

VERY HIGH-PRESSURE APPLIANCE - An appliance that uses a refrigerant with a boiling point below -50 degrees Centigrade at atmospheric pressure (29.9 inches of mercury). This definition includes but is not limited to equipment utilizing refrigerants -13 and -503.

*ARI - Air Conditioning Refrigeration Institute

*ASHRAE -American Society of Heating Refrigeration and Air Conditioning Engineers

* Acronyms (initials) for two of the largest and most respected professional organizations for the HVAC/R industries. Generally the standards set by these organizations are the guide used by the whole industry.

As you read this book you will see some of the standards and practices established by these two organizations are now used by the EPA for setting standards and practices now required to satisfy EPA regulations in support of the CAA set by congress.

EPA REGULATIONS
IMPORTANT DATES TO REMEMBER

1987- Montreal protocol signed by the United States and 22 other nations.

1990- Clean Air Act (CAA) Amendment of 1990 assigns EPA authority to control ozone depleting substances.

1992- As of 1 July 1992 it is illegal under Federal law to knowingly vent or release refrigerants in Class I or Class II into the environment.

1993- As of August 12 1993 all persons/contractors/shops must certify ownership of recovery machines to EPA. To satisfy this requirement all recovery (to include home made) must be registered with the regional EPA office for your area using an OMB# 2060-0256 Form.

1993- As of October 15 1993 all technicians must take a closed book examination to become certified under EPA rules.

1993- As of November 15 1993 recovery and recycling machines must meet stricter EPA standards pertaining to evacuation levels for machines manufactured after this date.

1994- As of November 15 1994 a technician cannot perform work on an air conditioning or refrigeration system requiring access to the refrigerant charge unless the technician is certified for that type of machine under an EPA approved program. For those programs that have been granted official "Grand Fathering" by the EPA 15 May 1995 is the date everyone must be certified.

1994- As of November 15 1994 no technician may purchase refrigerant in Class I or Class II unless they are certified by an EPA approved certification program.

1994- As of November 15 1995 it is illegal under Federal law to knowingly vent or release substitute refrigerants into the environment.

1995- Certification programs approved by the EPA office in Washington DC for grandfathering must be certified by 15 May 1995. (Effective 13 Feb. 1995, the DOD / EPA Certification is one of these programs).

1995- As of December 31 1995 it will be prohibited in the United States to manufacture or import CFC refrigerants.

2020- The year that refrigerants containing HCFCs in part or as a whole will be prohibited from manufacture. This dated could be moved forward as progress in finding a HCFC replacement is found. This also includes some of the new ternary refrigerants now being introduced and used as replacement refrigerants.

REQUIRED LEVELS OF EVACUATION FOR APPLIANCES
(EXCEPT FOR SMALL APPLIANCES, MVACS, AND MVAC-LIKE APPLIANCES)

	* Inches of Mercury Vacuum Using Equipment Manufactured:	
	Before 15 Nov 1993	On or after 15 Nov 1993
TYPE OF APPLIANCE		
HCFC-22 appliance** normally containing less than 200 lbs. of refrigerant.	0	0
HCFC-22 appliance** normally containing 200 lbs. or more of refrigerant.	4" Hg	10" Hg
Other high pressure appliance** normally containing less then 200 lbs. of refrigerant. (CFC-12, 500, 502, 114)	4" Hg	10" Hg
Other high pressure appliance** normally containing 200 lbs. or more of refrigerant. (CFC-12, 500, 502, 114)	4" Hg	15" Hg
Very High Pressure Appliance (CFC-13, 503)	0	0
Low Pressure Appliance (CFC-11, 113 and HCFC-123)	25" Hg	*** 25mm Absolute

*Relative to standard atmospheric pressure of 29.9" Hg
**Or isolated component of such an appliance.
ARI 740-1993
*** mm Absolute (Millimeters of Mercury Absolute)

REMEDIAL STUDY REFERENCES FOR CERTIFICATION TESTING

The information provided below is for you to use as study references for additional study in the event that you find that there are areas in the certification computer tests that you are weak in. You will find as you complete each test the computer screen will provide a test summary that will list a letter and how many questions you missed. For example under Core /Test 8000 for P you may have missed 4 of 5 questions. By looking below you will see under CORE/TEST 8000, P is 3-Rs and you will find in the book this subject is covered in Unit 3 and 8.

It is recommended that you use this information for additional self study if you are required to retake the computer test to achieve certification or as a quick reference if you are looking for information in general for your job/work requirements

CORE/TEST 8000

CODE	SUBJECT	REFERENCES
	OZONE DEPLETION	
D	OZONE DEPLETION/GENERAL	i pages - Unit 2
E	OZONE DEPLETION/CFC	Unit 2
G	OZONE DEPLETION/HCFC	Unit 2
H	OZONE DEPLETION/HFC	Unit 2
J	OZONE DEPLETION/EFFECTS	Unit 2
K	OZONE DEPLETION/EVIDENCE	Unit 2
	CLEAN AIR ACT AND MONTREAL PROTOCOL	
M	CAA/GENERAL	Unit 2 and 3
P	CAA/DISPOSAL	Unit 2 and 3
Q	CAA/PENALTY	Unit 3
R	CAA/PHASE-OUT	Unit 2 and 3
S	CAA/VENTING	Unit 2 and 3
T	MONTREAL PROTOCOL	Unit 3
U	CAA REGULATIONS	Unit 3
V	SUBSTITUTE REFRIGERANTS AND OILS	Unit 2, 7 and 8
W	REFRIGERATION	Unit 4 and 8
X	3-Rs	Unit 3 and 8
Y	LEAK DETECTION	Unit 3 and 7
Z	RECOVERY TECHNIQUES	Unit 3, 4 and 8
AA	DEHYDRATION	Unit 3 and 8
	SAFETY	
BB	SAFETY/GENERAL	Unit 3, 6, 9
DD	SAFETY/CYLINDER	Unit 2, 3, 9
HH	SHIPPING	Unit 10

TYPE I / TEST 8001

A	RECOVERY REQUIREMENTS	Unit 4 and 7
B	RECOVERY TECHNIQUES	Unit 2, 4, 5, 7, 8, 9, 10
C	SAFETY	Unit 4, 7, 9, 10

TYPE II / TEST 8002

A	LEAK DETECTION	Unit 3, 7
B	LEAK REPAIR REQUIREMENTS	Unit 4 and 7
D	RECOVERY TECHNIQUES	Unit 5 and 8
F	RECOVERY REQUIREMENTS	i pages, Unit 4 and 5
G	REFRIGERATION	Unit 4 and 5
H	SAFETY	Unit 9

TYPE III / TEST 8003

A	LEAK DETECTION	Unit 6
B	LEAK DETECTION REQUIREMENTS	Unit 6
C	RECOVERY TECHNIQUES	Unit 6
D	RECHARGING TECHNIQUES	Unit 6
E	RECOVERY REQUIREMENTS	i pages, Unit 5 and 6
F	REFRIGERATION	Unit 6
H	SAFETY	Unit 6

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COURSE CONTENT AND GOALS

This exportable course is designed as a self-paced, self-study course. The information in this book is the same information covered in all US certification programs. It is recommended that you study this material with other members in your shop. Sometimes it is helpful to work in groups. There will be a lot of material in this study guide that will be completely new and may be difficult to understand.

If you have any questions about this study material ,you may contact the USAF certification office at Sheppard DSN 736-5809. Any questions concerning processing the certification tests or your certificate can answered by calling DSN 736-5793. The FAX number for this office is DSN 736-3345.

Course Content

This course is designed to provide the training required to satisfy the United States Environmental Protection Agency's (EPA's) certification requirements for Type I,Type II, Type III or Universal Technician as required by EPA Regulation 40 CFR part 82, subpart F.

This course does not provide the hands on training for the operation of different types of equipment/devices used while performing refrigerant recovery, recycling, and/or reclaiming. The purpose of this course is to ensure that you are aware of the laws, rules, and regulations required to service the three types of systems as well as the common core issues.

At the end of the course you will be given a written test consisting of 100 questions. The test will be divided into 4 parts with 25 questions covering each of the three types of systems and 25 questions covering the common core issues.

The EPA has set a minimum standard of 70 percent for each part of the test that must be achieved to satisfy certification requirements. For those of you who do not achieve this minimum standard, you will be authorized to have time to restudy the area(s) that you failed and then you will be permitted a retake the test (only in the failed areas). The retake of the test will be a different version than the one you had taken before.

If you cannot achieve the 70 percent passing requirement established by the EPA, you will be eliminated from the course and possibly from the AFSC. It will be up to your unit commander as to what will be done for your case. It is possible that you may be rescheduled to retake the course at a later date. For this course the minimum passing score is 72% for each test.

This course does not ensure, nor is it capable of, certifying that you can perform the tasks required to recover, recycle, or reclaim refrigerants. It will be the responsibility of your base/unit/shop to certify and to maintain records that you are able to perform these tasks. This will be done by the OJT/certification program at your unit training office of your assigned base/squadron/unit.

Note that the EPA will be sending inspectors to all bases for regular inspections at no prearranged time. The purpose of the inspections is to ensure that EPA's policy and procedures are being upheld and include making sure that all personnel who service refrigerant charged systems are carrying an EPA-approved certificate.

Upon meeting EPA's minimum standards for Type I, Type II, Type III, or the Universal Technician, you will receive:

(1) An EPA-approved, personal, wallet-size certificate which must be carried with you at all times on the job.

(2) A full size certificate for your official records detailing the school graduated and when. A copy of the large certificate must be maintained in your shop or place of work.

Once you receive your EPA approved certificate, you will also be required to be certified as a qualified operator of the EPA-registered recovery, reclaim, and recycle equipment that's in your base/unit/shop. **NOTE ALL RECOVERY, RECYCLE AND RECLAIM SYSTEMS USED BY YOU OR YOUR SHOP MUST BE REGISTERED WITH THE REGIONAL EPA OFFICE FOR YOUR SHOP**. This certification training record will be maintained by your shop/squadron training office and must be provided to the inspectors for their inspection when they visit.

The EPA inspections will be done by either an EPA employee or an authorized EPA contractor. If you do not have both the EPA-approved certificate and the training records to show that you are qualified to operate the equipment and/or you cannot satisfactorily perform these tasks, your certificate will be pulled. You will then be required to be recertified again.

Thus, this means that after you have received the hands on certification training and have been certified competent to do the work by your shop, you will be authorized to service all types of refrigeration and air conditioning equipment that contains CFCs, HCFCs or any of the new replacement refrigerants coming onto the market.

The 366th Training Squadron HVAC/R school at Sheppard AFB TX will be issuing all certificates/diplomas for anyone that takes the test through any U.S. Air Force facility in the world. This also includes all DOD and other federal agencies that have a requirement for certification.

There are four levels of certification:

TYPE I TECHNICIAN

A Type I technician is a person who maintains, services, or repairs small appliances. This does not include MVACs (Mobile Vehicle Air Conditioners) or MVAC like systems.

TYPE II TECHNICIAN

A Type II technician is a person who maintains, services or repairs high pressure or very high pressure appliances and/or disposes high pressure or very high pressure appliances. This will also include a person that works with MVAC like systems.

TYPE III TECHNICIAN

A Type III technician is a person who maintains, services, or repairs low pressure and or industrial process appliances or disposes of low pressure or industrial process appliances.

UNIVERSAL TECHNICIAN

A Universal Technician is a person who maintains, services, or repairs high and low pressure systems, as defined in the Type I, Type II and Type III technician descriptions.

Technicians that service all three types of systems must be certified as Universal Technicians.

Because the USAF specialty for the Heating Ventilation Air Conditioning/Refrigeration (HVAC/R) career field requires technicians to service all types of refrigeration and air conditioning systems, the school applied for, and has been approved by the US EPA office in Washington DC, to certify USAF and other authorized government agency personnel as universal technicians.

On 19 May 1994 the USAF program was officially changed to an all encompassing DOD program covering all four types of certification under the EPA 608 HVAC/R certification program. Now all military certification programs are now under a single program administered by the 366th Training Squadron located at Sheppard AFB.

YOUR RESPONSIBILITIES

THE EPA HAS MANDATED THAT IT IS YOUR RESPONSIBILITY TO KEEP CURRENT OF ALL FEDERAL, STATE AND LOCAL LAWS AND REGULATIONS. THE 366 TRAINING SQUADRON DOES NOT AND CAN NOT FURNISH THIS INFORMATION AS EACH LOCATION MAY HAVE DIFFERENT LAWS AND REGULATIONS. This book is up dated as required to keep current with certification test changes only. The test does not change every time the federal laws are changed. The Certification test does not cover state or local civil laws nor does it cover military rules, regulations or directives.

Where you must go to keep up to date is dependent on your unit of assignment. The following are suggestions that may be useful for USAF installations.

1. Your unit's Environmental/Hazardous material office.
2. Your Base Civil Engineering Environmental Flight (CE/CEV)
3. Civil Engineering Refrigerants/Hazmat Control
   HQ AFCESA/CESM Tyndal AFB Fl DSN 523-6315
4. AF-EMIS Help Desk 1-800-484-9178 Ext EMIS 4214
5. PRO-ACT DSN 240-4214
6. The EPA Refrigerant/Lubricants/Associated Equipment Point of Contact
   10:00 AM - 4:00 PM Monday thru Friday Eastern Time (USA)
   1-800-424-9346 or 703-920-9810
7. The EPA HOT LINE 1-800-296-1996

QUESTIONS:

1. What will the minimum passing score be to pass any one of the certification tests?

2. What will happen if you do not achieve the minimum passing score for certification in any one of the different types certification tests?

3. What does the law require for you, the technician, to have in order to service refrigeration equipment?

4. A person issued a Universal Technician certificate will be authorized to service what type(s) of refrigeration equipment?

5. What other requirements must a service technician satisfy prior to working on refrigeration equipment?

ENVIRONMENTAL IMPACT OF CFCSs AND HCFCs

OBJECTIVE

2a. Identify the impact of CFC/HCFC refrigerants on the, world environment by answering a series of questions.

INTRODUCTION

By now you are well aware of the dangers that man-made pollutants have had on the world's environment.

It doesn't seem that a day goes by that we don't hear of something new that causes some sort of environmental impact or damage to the air, water or earth.

At one time, no one paid much attention to the global environment. It was thought that the earth was so big that trashing it wouldn't do much harm. However, as populations grew and man's way of life changed throughout the ages, these effects have taken their toll on the quality of the world's environment.

Concern for the ozone layer is not a new subject. Scientists have been watching and measuring the changes in the ozone protective layer that covers the earth in the stratosphere since the 1930s.

The United States Environmental Protection Agency has supplied the following reprint from the ASHRAE (American Society of Heating and Air-Conditioning Engineers) Journal and has made it required reading to prepare you for the certification program.

The article will answer many questions that you may have concerning the CFC controversy. In addition, it will provide you with valuable information concerning the make up, function, and how CFCs/HCFCs affect the ozone layer.

INFORMATION

The CFC Controversy: Issues and Answers

The author addresses numerous misconceptions that still remain about CFCs and the ozone layer.

By F. Sherwood Rowland, Ph.D., D.Sc.

About the Author:

F. Sherwood Rowland is the Donald Bren Professor of Chemistry at the University of California-Irvine, where he specializes in atmospheric chemistry and radiochemistry and has published more than 300 scientific articles in these fields. He has BA and LLD degrees from Ohio Wesleyan University; MS, PhD and DSc degrees from the University of Chicago; as well as honorary degrees from Princeton University, Duke University, Simon Fraser (Canada) University and Whittier and Haverford Colleges. He is an elected member of the National Academy of Sciences and of the American Academy of Arts and Sciences, a fellow of the American Physical Society and the American Geophysical Union, and a member of the American Chemistry Society. During 1992, he is serving as president of the American Association for the Advancement of Science.

Statements: "The Rowland theory ignores the equilibrium nature of ozone in the layer"[1]. One of the strongest arguments against the ozone depletion theory is that the ozone molecules in the atmosphere are constantly being replenished because, in nature, they are continuously being created and destroyed.

Reply: Ozone is constantly being made and destroyed, which has been thoroughly emphasized in the Rowland-Moline theory[2] (and all other scientific discussions of the relationships between CFCs and ozone). The problem is that the decomposition of CFCs in the stratosphere release chlorine atoms that add substantially to the natural ozone destruction rate.

From a technical point of view, the ozone/oxygen relationship in the atmosphere is not a chemical equilibrium, but a photochemical steady state. The constant bombardment of the atmosphere by solar ultraviolet (UV) radiation keeps producing ozone, and the various chemical reactions keep changing the ozone back into molecular oxygen, thereby maintaining a steady level. As the CFC concentration increases and the rate of chlorine removal of ozone increases, the globally averaged ozone concentration is maintained at a lower level.

Statement: CFC molecules are much heavier than air and therefore cannot rise into the stratosphere.

Reply: The CFCs are indeed much heavier than air and, in enclosed spaces such as a laboratory or a refrigeration system, they do tend to concentrate near the bottom. However, in the atmosphere (or in a laboratory with a fan), the mixing of gasses is controlled by the wind-driven motion of large air masses that distribute both light and heavy molecules equally and rapidly. This was already well established before the CFC-ozone connection was first discussed. More than 10 chlorocarbons and bromocarbons (all of them much heavier than air) have been quantitatively measured in the stratosphere during the last 17 years. Literally thousands of measurements of CFC concentrations have been made in the stratosphere since the first data collected in 1975.

1 Pease, R.N. 1989. "Ozone chicken littles are at it again." The Wall Street Journal Co. March 23

2 Rowland, F.S., Molina, M.J. 1975. "Chlorofluoromethanes in the environment". Reviews of Geophysics and Space Physics. Washington, DC: American Geophysical Union. Vol. 13, NO. 1, pp. 1-35.

Statement: The amount of chlorine introduced into the atmosphere during the 1980s by cholofluorocarbons and other chlorocarbons (more than one million tons per year) is completely unimportant relative to the 300 million tons of chlorine per year from the evaporation of seawater alone.
Reply: The ozone depletion problem is not caused by chlorine in the atmosphere but the chlorine in the stratosphere. Sodium chloride particles left in the lower atmosphere from the evaporation of oceanic sea spray quickly dissolve in raindrops, rain back to earth's surface, and do not reach the stratosphere. Atmospheric measurements confirm that water-soluble chloride (either hydrogen chloride or sea salt) decreases very rapidly in atmospheric concentration at higher altitudes because of the cloud droplet effect. However, the CFCs are nearly insoluble in water and are not removed by rainfall.

Statement: Volcanoes inject hundreds of millions of tons of chlorine into the stratosphere in the form of hydrochloric acid, far more than reaches there from the CFCs.

Reply: Large quantities of hydrochloric acid (and steam, sulfur dioxide, rock, etc.) are certainly present in volcanic plumes.

Most volcanic eruptions are rather mild and the plumes do not rise very much before dispersing. However, because the largest volcanic eruptions do penetrate the stratosphere, scientists in the early 1970s seriously considered the possibility that volcanoes could be an important source of hydrogen chloride for the stratosphere. However, regular measurements of hydrogen chloride concentrations in the stratosphere itself have shown very little effect from volcanic eruptions while increasing steadily in amounts consistent with the CFC source.

The very large volcanic eruption of El Chichon in 1982 increased the total amount of stratosphere chlorine by about 10%, only to fade into the CFC background in about a year. The June 1991 eruption of Mount Pinatubo caused no measurable increase in total stratospheric chlorine.

The Antarctic volcano, Mount Erebus, has not had a recent major eruption, and the plume from its steady release does not penetrate into the stratosphere. The probable explanation for the absence of hydrogen chloride in the volcanic plume when it reaches the stratosphere is that the large volumes of steam emitted in the eruption condense into water droplets that rain back down into the lower part of the plume, carrying the hydrogen chloride dissolved in them. This effectively scrubs the hydrogen chloride out of the rising volcanic plume before it reaches the stratosphere. The stratosphere itself is extremely dry.

Statement: There has never been any recorded chemical reaction between ozone and CFCs. Even in laboratory experiment, they cannot be forced to destroy each other.

Reply: Of course ozone and CFCs do not react with each other; that's one reason why inert CFCs can survive for decades in the lower atmosphere. However, in the mid-stratosphere, CFCs can be destroyed by solar ultraviolet radiation, thereby releasing chlorine atoms that do react with ozone.

Question: When the ratio of molecular oxygen (O_2) to CFC molecules is 400,000,000 to 1, how does a photon of ultraviolet (UV) radiation stand any chance of striking a CFC molecule?

Reply: Most ultraviolet photons are absorbed by (O_2) and ozone (O_3) molecules, just as they always have been. However, a small fraction of the billions and billions of photons are absorbed by the CFCs in proportion to their relative abundance and carefully measured individual UV-absorption characteristics.

Statement: Environmentalists alleged that various chemicals (from pesticides to fertilizers), nuclear tests and vehicles ranging from the supersonic transport to the space shuttle were going to poke holes in the ozone layer. Every such theory were proven wrong by scientific observation of the behavior of the ozone layer.

Reply: This statement is totally incorrect. The scientific investigations of the early 1970s identified four chief possibilities for the depletion of stratospheric ozone: chlorofluorocarbons (CFCs), the space shuttle, supersonic transports (SSTs) and nuclear testing in the atmosphere. The conclusions then were that: the space shuttle would have only a minor effect on stratospheric ozone unless flights reached a several-times-per-week schedule; nuclear testing did cause an ozone decrease around 1960; SSTs, if built in the planned numbers of several hundred, would cause ozone depletion; and the CFCs and closely related bromine compounds of the halon family would cause ozone depletion at their existing rates of use. None of these conclusions has been abundantly proven to be correct, and the ozone data from 1955 to 1963 (although less abundant than in the past decade) do indicate losses from the atmospheric nuclear testing that largely ended by 1962. The existing network of U.S. ground-based stations for measuring total ozone began taking data in January 1963, too late to be of much use for detection of nuclear test effects on ozone. The other two theories are, as yet, untested.

Space shuttle flights have averaged several per year over the past decade, rather than several per week, so the effect on ozone has not been tested.

Similarly, the number of Concord aircraft flying is not several hundred, but fewer than 10, and the Boeing SSTs were never built, so there is no actual observational evidence about SSTs and ozone depletion.

Extensive experiments and calculations are now being conducted to determine again the SST effects for the 1990's atmosphere, with its greatly increased concentrations of CFCs. The problem with the SSTs is not their speed, but the altitude at which they fly; the Concord flies at about 56,000 feet and the Boeing SST was proposed to fly at 70,000 feet. The emissions from current commercial aircraft (flying mostly at 30,000 to 40,000 foot altitudes) are calculated to cause small increases in total ozone. While some military aircraft have flown at the higher altitudes, the number of flight hours (and tons of fuel burned) are very small in comparison to the flight hours of military aircraft at commercial altitudes.

Statement: The CFCs cannot possibly be important greenhouse gases; after all, there is only one CFC molecule for every 700,000 molecules of carbon dioxide (CO_2) in the lower atmosphere.

Reply: The concentration of (CO_2) at 350 parts per million by volume (ppmv) is indeed 700,000 times greater than the 500 parts per trillion of CFC-12. However, the various kinds of molecules do not absorb infrared radiation (the basic radiation of the greenhouse effect) equally well. For example, the major components of the atmosphere - nitrogen (N_2), oxygen (O_2) and argon (Ar) - are all transparent to terrestrial infrared wavelengths.

Furthermore, each kind of molecule absorbs only certain infrared wavelengths that correspond to specific motions in the absorbing molecule. (CO_2) molecules absorb a certain set of wavelengths; CFC-12 molecules absorb another, non-overlapping set of wavelengths. The 350 ppmv of (CO_2) already absorb almost all of the infrared radiation in the (CO_2) wavelengths, so that another molecule of (CO_2) is not very effective in absorbing further infrared because very little is available. On the other hand, CFC-12 is present in concentrations 700,000 times lower, and most infrared radiation in the CFC-12 wavelengths is still getting through, so an additional molecule of CFC-12 is still fully effective.

However, it is very important to note that, even though additional (CO_2) molecules are relatively ineffective on a per-molecule basis, the rate of increase of (CO_2) in the atmosphere (about 1.5 ppmv per year) is so much larger than that of the CFCs that (CO_2) is the most important greenhouse gas.

Statement: Calculations for UV radiation at 210 manometer wavelengths (UV/210) indicate that there will be one CFC molecule for every 130,000,000 normal oxygen molecules in the ozone layer at 25 kilometers (15 miles) altitude. If we make the large CFC molecule a three-times better target for UV/210 photons than the small oxygen molecule, there will be 45,000,000 ozone molecules created for each CFC molecule that is decomposed.

Reply: The ability of a molecule to absorb radiation is not determined solely by its size, as implied in this statement, but by its detailed electronic structure. Molecular oxygen (O_2) is transparent to visible radiation, while nitrogen dioxide (NO_2) has a brown color because it does absorb visible radiation. Laboratory measurements show that a molecule of CFC-11 is 24,000 times more efficient in absorbing UV/120 photons than is (O_2).

Statement: Because the same narrow band of ultraviolet light breaks down both CFCs (releasing their ozone-destroying chlorine) as well as oxygen (creating ozone), there is a "competition" between the two processes for this necessary solar energy. The probability that an oxygen molecule will be broken apart, rather than a CFC molecule, depends on the relative abundance of the two gases in the ozone layer. Calculations show 60,000 ozone molecules are created for every chlorine atom released from a CFC molecule.

Reply: The Towlan-Molina theory (and all of the subsequent calculations) has always strongly emphasized the competition between (O_2[H1]) and the CFCs for ultraviolet radiation. Because ozone in the stratosphere absorbs UV radiation very well, CFC molecules in the lower atmosphere are completely protected by the ozone overhead.

Only when the CFCs have randomly wandered to altitudes of 25 kilometer (15 miles) or higher is sufficient solar UV radiation of the right wavelength still present for CFCs to absorb any of it. No one has said that the CFCs absorb all, or most, or even a significant fraction of the incoming UV radiation. Most of this radiation is still absorbed, as it always has been, either by molecular oxygen (O_2) or by ozone (O_3). Absorption by (O_2) causes it to split into two oxygen (O) atoms, and these are usually each caught by other (O_2) molecules to make more ozone (O_3). The CFC molecules absorb only a very minor fraction of the incoming UV radiation with wavelengths. However, chlorine atoms remove (O_3) by a chain reaction in which one atom of chlorine can remove 100,000 molecules of ozone. This allows a smaller number of chlorine atoms to remove globally significant numbers of ozone molecules.

Statement: Many of the scientists now researching the ozone hole believe it is a natural phenomenon, with CFCs playing a minimal role, if any. This view is reflected in the November 1986 special issue on Antarctic ozone depletion of the Geophysical Research Letters. In an overview of the 46 scientific papers presented in the special issue, Mark K. Schoeberl and Arlin J. Krueger from the NASA/Goddard Space Flight Center state: Despite the number of public pronouncements, no clear link between manmade pollutants and ozone depletion over Antarctica has been established; indeed, a number of papers on this issue present serious alternatives to and constraints on the suggested chemical scenarios. The appearance of the South Polar total ozone minimum and higher values at mid-altitudes in the spring has been observed since the late 1950's, well before man-made pollutants could have had any important impact on the stratosphere[3].

Reply: Six years ago in August 1986, when these scientific papers were submitted to Geophysical Research Letter, there was genuine scientific disagreement about the cause of the Antarctic ozone hole. Some scientists believed then that the Antarctic ozone hole was primarily caused by chlorine atoms released from CFCs.

Other scientists at that time believed that alternative, natural explanations for the ozone losses over Antarctica would turn out to be the cause, and many of these suggestions were contained in this special issue of Geophysical Researched Letters. Two land expeditions to Antarctica in August/September 1986 and 1987 and another by air over Antarctica from Chile in 1987 provided data that convinced the scientific world that CFCs were indeed responsible.

The 1988 Executive Summary of the NASA Ozone Trends Panel report stated: "The weight of evidence strongly indicates that man-made chlorine species are primarily responsible for the observed decrease in ozone within the polar vortex"[4].

The statement quoted above, in addition to being six years out of date, also ignores the next paragraph of the overview of Schoeberl and Krueger, which emphasizes the changes observed during the early 1980s.

What has changed recently is the value of total ozone in the minimum has declined from about 260 D.U. (Dobson units) in 1985. A decline of about 70 D.U. has also been noted in the maximum region[5].

3 Schoeberl, M.K., Krueger, A.J. 1986. "Overview of the Antarctic ozone depletion issue". Geophysical Research Letter. Washington, DC: American Geophysical Union. Vol. 13, No. 12, pp. 1191-1192.

4 NASA. 1988. "Executive Summary". Report of the International Ozone Trend Panel. Washington, DC: National Aeronautics and Space Administration. March 15.

5 Schoeberl, M.K., Krueger, A.J. 1986. "Overview of the Antarctic ozone depletion issue". Geophysical Research Letter. Washington, DC: American Geophysical Union. Vol. 13, No. 12, pp. 1191-1192.

Statement: The Antarctic ozone hole grew during the early 1980s, becoming large in 1985, smaller in 1986, and reaching its greatest size in 1987. In 1988, the hole did not appear as expected. It was finally discovered; only 15% as large as predicted and displaced over the ocean.

Reply: The Antarctic ozone losses first became significant about 1979 and the losses continued to become greater as the years passed, but not steadily larger every year. The losses in 1988 were indeed not as great as in 1987 and were otherwise different, too, with a pattern of higher losses than usual during August and lesser ozone losses in September and October. The 1988 Antarctic ozone levels were about 30% below those characteristic of the mid-1970s and were only small in comparison to the massive loss in 1987. Antarctic ozone depletion was approximately the same in 1987, 1989, 1990 and 1991.

The ozone loss over Antarctica in 1992, is, in some ways, the most severe yet observed. The area with ozone values below 220 D.U. reached 9,000,000 square miles, which is three times the size of the continental United States.

The alternating behavior of the early 1980s has been replaced by a more consistent, massive ozone loss in each of the last four years and five of the last six years. Of course, the amounts of the CFCs in the atmosphere have increased steadily over the past five years.

Statement: The ozone hole was actually discovered in 1956 by the world's leading ozone layer researcher, Gordon Dobson, and his collaborators. Back in 1956, CFCs were not in widespread use. The existence of the hole could not be blamed on them. Dobson correctly postulated the ozone hole to be a fascinating natural anomaly.

Reply: In 1956, Dobson discovered what is now described as the Antarctic polar vortex, not the ozone hole. In 1956, essentially nothing was known about Antarctic ozone meteorology. Professor Dobson, preparing for the International Geophysical Year (1957-58), made the tentative hypothesis that the springtime ozone levels in the Antarctic would be like the springtime levels in the Arctic. That is, September at Halley Bay, Antarctica, would be like March at Spitzbergen, Norway, with both locations having about 450 Dobson units (D.U.) of total ozone.

However, when the first reports came in of about 300 Dobson units of ozone over Halley Bay (76 degrees S latitude) in September, Dobson noted that they were 150 D.U. below their expectations.

In contrast to this expected 450 D.U. and observed 300 D.U. in 1956, currently observed Antarctic ozone levels were as low as 125 D.U. in 1989, 1990, and 1991, and 106 D.U. in 1992. The cause of the discrepancy recorded by Dobson is the very strong Antarctic polar vortex that prevents the arrival over Antarctica of ozone-richer air from temperate latitudes until about mid-November.

With the weaker Arctic vortex, such mid-latitude ozone-richer air can reach Spitzbergen (78 degrees N latitude) in March and April, producing the higher ozone levels measured there. Incidentally, ozone levels in the tropics are in the 250-280 D.U. range were already well-established for tropical latitudes.

The Halley Bay values of 300 D.U. were low only in comparison with the expectations based on Arctic observations. Decreases in ozone during the month of September were not observed at Halley Bay during the two decades from 1956 to 1975, but began appearing in the late 1970s. This timing of the appearance of the ozone hole is totally inconsistent with volcanoes as it source. Volcanoes have been known for thousands of years, and the volcano Fuego had a very large eruption in 1974 without effect of Antarctic ozone concentrations.

Statement: Because the Antarctic ozone hole grew suddenly, while stratospheric chlorine increased only slightly, the process must have been triggered by other factors.

Reply: The chlorine content of the atmosphere in the forms of CFCs, carbon tetrachloride, methyl chloroform and methyl chloride was about five times larger in 1992 than in 1957. This is a very sudden increase, paralleling the suddenness of ozone loss over the Antarctic.

Statement: The loss of ozone during the polar night is caused by the same interaction of the solar wind with the Earth's magnetic field that causes the auroras. Solar wind is the product of solar flares, which are more frequent as sunspot activity increases.

Reply: Auroras and sunspots have been known for centuries and, therefore, could not explain by themselves an ozone loss observed only in the past decade. However, this statement is fundamentally wrong in still another way. Actually, no reduction in ozone has been observed during the polar night over Antarctica. The amount of ozone in late winter (August 15) over Halley Bay is essentially the same as in April when the polar night begins. (While ozone measurements are usually made by observing the sun with a Dobson spectrometer, measurements of lower precision can be made by moonlight during the polar night. These measurements show no change in ozone concentration over the period of winter darkness.) Sunlight is a key ingredient for Antarctic ozone loss, beginning in late August for Halley Bay.

Statement: The trigger for the Antarctic ozone hole has been a gradual cooling of the stratosphere, which took the temperature below the freezing point. This cooling could have occurred as part of the general climate fluctuation of the earth.

Reply: Measurements of stratospheric temperatures have been conducted by balloon-borne instruments at Halley Bay, Antarctica, since 1956. The mid-winter (July, August and September) temperatures in the late-1980s all fell within the range established from 1956 to 1975, so that the very deep ozone hole in 1987, for instance, was preceded by no unusual stratospheric temperatures. The stratospheric temperatures over Halley Bay in October and November 1987, (after the ozone hole had formed) were lower than in the earlier decades.

These changes can best be described as a failure to warm up as rapidly as in previous years from the late-winter low temperatures. The cause for this delayed warming process is the absence of ozone that had, in previous years, absorbed solar ultraviolet radiation and converted it into heat.

Statement: The ozone trend analysis reported by the NASA Ozone Trends Panel in 1988 are seriously flawed because 1969, the year the panel fixed as the starting point for the analysis, came near the peak of the solar sunspot cycle. The decrease NASA reported from 1969 to 1986 may just have been the variation in stratospheric ozone from the natural solar cycle.

Reply: This frequently repeated statement is simply false, the result of an erroneous, careless reading the NASA Ozone Trends Panel Report. The data used in that report covered a 22-year period from January 1965 to December 1986, including two complete 11-year solar sunspot cycles. The baseline comparison did not start at a sunspot maximum and end at a minimum, but both started and ended near minimum in the sunspot cycle. When the effects of the two complete solar cycles are removed from the original data, a downward trend toward lower ozone is found. This loss of ozone can be expressed in various ways, one of them being the average yearly loss for the time period from 1969 to 1986. However, this trend was calculated from 22 years of data that began in January 1965, with the first years used to establish the baseline and evaluate the full solar cycle effects.

Question: If stratospheric concentrations of ozone have decreased, why has no one measured an increase in ultraviolet radiation?

Reply: They have. The standard Dobson ozone spectrometer used since the 1930s for measuring total ozone actually measures ultraviolet radiation coming directly from the sun. This instrument records the ratio of radiation received at a UV-B wavelength versus that at a UV-A wavelength. With more ozone in the stratosphere, less UV-B gets through and the ratio is smaller; with less ozone, more UV-B penetrates and the ratio is larger. Separate measurements do not indicate any change in the solar emission of UV-A. Therefore, when a Dobson station in a remote location reports a loss of ozone, what is really measured is an increase in the UV-B/UV-A ratio and, therefore, an increase in UV-B have been directly measured in Antarctica by more sophisticated UV instruments.

The situation for Bobson stations in urban areas as they become more polluted is more complicated and has often been quoted as though it were very simple. Besides the Dobson spectrometers, other instruments have also been designed to measure total UV-B received both directly from the sun and when it is scattered by air molecules so that it arrives indirectly. (The blue color of the sky comes from the scattering of blue/violet sunlight by the air molecules and is essentially sunlight arriving at the eye indirectly.) One such instrument, the Roberson-Berger meter, has recorded increases over the years in total UV-B radiation (direct plus indirect) when used in the Swiss Alps. Another instrument similar to the R-B meter recorded a sharp increase in total UV-B over Melbourne, Australia in December 1987, corresponding to a rapid 10% drop in total ozone as measured with a Dobson spectrometer. However, a set of R-B meters operated in American locations has not indicated increases in total UV-B radiation.

These instruments have mostly been placed in urban locations (e.g., near airports) in which ground-level pollution, including ozone and particles, has increased over the past 18 years. Ground-level ozone pollution can reduce the amount of indirect UV-B radiation in much the same way that visibility is reduced by particle pollution, with the consequence that the total UV-B radiation (direct plus indirect) does not increase as stratospheric ozone decreases.

As these urban areas become more polluted, the decrease in stratospheric ozone may not be accompanied by an increase in total UV-B radiation. But, the population will be correspondingly more heavily exposed to the health effects from smog conditions including ground-level ozone.

Question: If the ozone is actually being depleted, why not just make some and ship it up there? Will Los Angeles smog not do it?

Reply: The power level associated with the natural formation of stratospheric ozone by the action of solar ultraviolet radiation on the atmosphere is about 24 terawatts. The power level for all of man's activities (coal, oil, gas, nuclear, hydro, etc.) is about 10 terawatts. The natural system is just too massive to be significantly supplemented by mankind. The difference between creating and destroying ozone is in the energetics. Energy is required to make ozone from molecular oxygen; about 3 electron volts (ev) per oxygen (O) atom (which soon becomes an O_3 back to O_2 because that process is downhill energetically).

You make ozone one molecule at a time, at a cost of 3 ev per molecule. But the chloride chain reaction can destroy thousands of ozone molecules in rapid succession at no energy cost at all, because each reaction step actually releases energy. The ozone concentrations in the stratosphere are higher than those in Los Angeles, so the actual direction of new ozone flow from the stratosphere is downward. An ozone concentration of 120 parts per billion (ppb) leads to a smog alert at the ground level, while concentrations of 5,000 ppb can occur in the stratosphere.

Refrigerants Effecting the Ozone Layer

There are 3 classes/types of refrigerants, two of which are a concern because they will effect the breakdown of the ozone layer. Type I (CFCs) and Type II (HCFCs) this includes the new refrigerants that contain HCFCs as part of their makeup.

I

CFC REFRIGERANTS

CHLOROFLUOROCARBON (R-12, R-500, R-502, R-11 and R113)

C = CHLORINE F = FLUORINE C = CARBON

These refrigerants have the greatest ODP rate and are the most destructive to the ozone layer. They are the first on the list to be banned from manufacturing. No CFC refrigerant will be manufactured or imported into the US from anywhere after 1995. As you can see the name for this group of refrigerants indicates the 3 elements used to manufacture this type of refrigerant

II

HCFC REFRIGERANTS

HYDROCHLOROFLUOROCARBON (R-22 and other refrigerants containing R-22)

H = HYDROGEN C = CHLORINE F = FLUORINE C = CARBON

This refrigerant has a lower ODP, but is still destructive to the ozone layer. HCFCs are less destructive than CFCs, but is also on the list scheduled to be banned, but the ban is scheduled to take place at a later date. As you can see, this refrigerant has 4 elements.

III

HFC REFRIGERANTS

HYDROFLUOROCARBON (R-134a and other refrigerants that are chlorine free)

H = HYDROGEN F = FLUORINE C = CARBON

This is the only refrigerant that does not have any known destructive effects on the ozone layer. (((**This refrigerant is now being used as a replacement for CFC R-12 but is not what is called a drop-in refrigerant**))). Because not all is known about this new refrigerant venting and purging is not legal under existing EPA law after 1995.

As of this printing manufacturers have developed and have received EPA approval for several new refrigerants called NEAR DROP IN REPLACEMENTS FOR R-12 AND R-22 THESE REFRIGERANTS ARE NOT DROP IN REFRIGERANTS. They have been designed to be used with both the new types of refrigerant oils and the old mineral types of oils of the old days. The advantage of these near drop in refrigerants is old systems can be recharged with out refitting required by the new HFC refrigerants.

Something that should be noted about HFC type refrigerants is they lack one element. That element is chlorine. All the CFC and HCFC refrigerants do contain chlorine.

Chlorine, then as you can surmise, is the culprit that is so destructive to the ozone layer. It should be noted that not all chlorines are destructive to the ozone layer.

There are two types of chlorine that concern us:

(1) Chlorines that are water-soluble (dissolved in water) and are washed back to the earth by rain before they reach the heights of the stratosphere where the ozone's protective layer is located. For example, sea water (salts), water purifying chlorine and chlorine used in cleaning solutions.

(2) The chlorine in the chlorocarbons found in CFCs and HCFCs refrigerants that are non water-soluble (not dissolved in water) and do rise to the ozone levels of the stratosphere.

For each chlorine atom that reaches the stratospheric ozone layer, it is capable of destroying 100,000 ozone particles that it comes in contact with.

Each ozone molecule or particle contains 3 oxygen atoms, therefore, for each chlorine atom that reaches the stratosphere it is capable of destroying 100,000 ozone particles that it comes in contact with.

One can only imagine with the millions of tons of chlorocarbons that get up to the stratosphere per year, the number of atoms coming in contact with the ozone particles computes out to a horrible destruction of ozone safety shield.

This is what has given rise to the urgency for eliminating this potential health hazard. If the ozone protective layer continues to be destroyed, the effects on the world will be devastating. The ozone layer acts as a filtration system by filtering out the harmful infrared (UV) radiation that comes from the sun and would reach the earth if it were not for the ozone filter in the stratosphere.

Ultraviolet/infrared radiation has been discovered to cause a whole list of harmful effects upon man and the environment. Some of those effects are skin cancer, eye cataracts, the reduction of crop yields and marine life which cause widespread famines. Then, as ground-level ozone increases this deadly gas can and would kill all animal life.

SUMMARY

There are those who will argue that this whole ozone depletion concern is just a lot about nothing and that mother nature will take care of everything. But the facts are in and if nothing is done about protecting the ozone protective layer, in time, there will be no life on earth as we know it today.

Fact CFCs and HCFCs that contain non-water soluble chlorine were found when testing the stratosphere.

Fact The rise of non-water-soluble chlorine in the stratosphere matches exactly the rise in CFC and fluorine usage for the past 20 years.

Fact Contrary to popular belief, the recent volcanic eruptions over the past decades have shown that they have contributed minimal quantities of chlorine to the stratosphere as compared to CFCs.

Fact Chlorine monoxide which has been traced to CFC and HCFC refrigerants is what is destroying the ozone layer.

Now that the facts are in, the next step is what to do about protecting the ozone.

QUESTIONS:

1. List the CFC types of refrigerants.

2. List the HCFC types of refrigerants.

3. Why are HFC refrigerants so safe to the environment?

4. What are the types of chlorine that concern the environment?

   and

5. What effect will the depletion of the ozone protective layer have on the earth and your health?

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EPA LAWS, REGULATIONS, AND THE CHANGING INDUSTRIAL OUTLOOK

OBJECTIVE

3a. Identify EPA laws, regulations, and the changing industrial outlook concerning the elimination of CFC/HCFC contamination by answering a series of questions.

INTRODUCTION

As stated before, the facts are in. The next step is what to do about it. The EPA and industry have come together, studied the facts, and decided that action must be taken. Their course of action is for us to capture and ultimately eliminate the ozone-depletion substances.

INFORMATION

Laws and Regulations

The United States government has taken steps and passed laws that are designed to reverse the trend of destroying the ozone protective layer. Since the United States is the largest consumer for CFC/HCFC products, it stands to reason that the U.S. would be one of the first to take steps in eliminating the problem. The Clean Air Act (CAA) of 1990 set many standards and rules such as a phaseout of CFC/HCFC production, prohibiting CFC/HCFC venting and having standards for recovery of refrigerants. Updates to the CAA include a revision to the Act on May 14, 1993. Some of these laws that are now enforced are subject to huge fines if violated. Some of the fines that are as high as $25,000.00 per day per violation include:(See Aug 95 update PAGE 1-13)

1. Knowingly venting CFC/HCFC refrigerants after 1 July 1992 or venting substitute refrigerants after November 1995.

2. The failure to recover all refrigerants while servicing, opening, or disposing of any refrigeration/air conditioning appliance.

3. Leak checking any appliances by pressurizing a fully-charged refrigerant system with nitrogen. Do not confuse this with leak testing using a tracer refrigerant.

4. Prior to disposing (salvage or recycling) of any refrigerant storage cylinder either disposable or reusable, the refrigerant must be recovered and the container rendered or made useless. The metal should then be sent in for recycling.

5. All state and local laws to include military regulations must be followed as long as they are equal or even more strict than current CAA/EPA laws. If local, state laws, or military regulations are less stringent, then CAA/EPA laws take president and must be followed.

6. Knowingly falsifying EPA required records such as training records, refrigerant leaks on certain systems and refrigerant usage.

7. Failure in registering and de-registering of your recovery, reclaim, and recycling unites with the regional EPA office for your district with in 30 days of purchase or disposal.

(Manufacturers must recertify recovery systems every three years while you must have recovery/storage cylinders hydrostatically tested and recertified every five years.)

NOTE: SEVERAL AIR FORCE INSTALLATIONS HAVE ALREADY BEEN HIT BY THE INSPECTORS AND HAVE BEEN WRITTEN UP FOR INFRACTION ALREADY

See Aug 95 EPA Final Rules Summary in front of the book

Penalties, Fines and Enforcement

Without some sort of enforcement, laws have no value. The penalties and fines can be leveled against anyone that breaks the law. This is not only true for the service technician, but property owners, manufacturers, and dealers. It affects the whole industry.

The EPA has several ways of finding out who is breaking the law. (1) ANYONE, MILITARY OR CIVILIAN who sees the law broken may turn this information in to the authorities on their own. If, after an investigation it is proven that laws were broken, the person who provided the information can receive an award as high as $10,000.00. The person turning this information in can be anyone. not necessarily someone connected with the industry. (2) Inspections made by the EPA or a company contracted by the EPA to perform both scheduled and non-scheduled inspections. A conviction for breaking the law can include all of the following:

(1) A fine up to $25,000.00 per day per violation for as long as the violation has been in effect.

(2) The loss of the EPA certification which will prohibit you from purchasing refrigerants and servicing any refrigerant charged equipment.

(3) The requirement to appear in federal court as the laws are federal.

So, as you can see, the laws now have some bite. Failure to obey them will hurt. The military laws can be even more severe because the UCMJ is very strict when it comes to breaking federal rules and regulations.

Changing Industrial Outlook

As stated previously, CFCs will not be manufactured nor imported into the USA after 1995. This will have profound effects on the entire industry. Today, millions of appliances and devices rely on CFC refrigerants to function. All of these will have to be eliminated or converted to environmentally-safe refrigerants.

The government knows that these appliances cannot be discarded all at once. In order to take care of this problem and to keep a supply of CFCs to service and repair, the recovery and recycling of CFCs will take place until the equipment is replaced.

By recovering CFC refrigerants, it will prevent the venting of CFCs to the atmosphere, preventing the stratosphere ozone from being depleted, and provide a supply of refrigerant after the production ban.

The Montreal Protocol Agreement

The Montreal Protocol is a treaty that was signed by most of the world's industrialized nations that will control the production or manufacturing of chlorofluorocarbons, hydrochlorofluorocarbons, and halons. The United States is one of the charter nations that signed this agreement.

CAA Reclaim/Recovery Regulations

All devices used to reclaim and recover CFC and HCFC refrigerants for all air conditioning and refrigeration equipment must conform to EPA regulations and standards. These regulations and standards were established under the authority of the CAA Act of 1990.

Under EPA regulations to ensure an adequate supply of CFC and HCFC, refrigerants can be resold to the public but, only after it has been reclaimed and meets the ARI 700 standards.

The EPA describes several devices used in recovering, reclaiming, and recycling of refrigerants. Recovery devices only remove refrigerants from an appliance and hold it until it is put back into the appliance again.

Recycle equipment will clean and separate oil from the refrigerant as it passes through unit. This system will not clean the refrigerant to new or virgin standards. Only reclaim equipment can bring refrigerants back to new standards. This is done mostly by commercial companies today.

There are several types of these devices that you must know about:

(1) System-dependent recovery device is a device that captures refrigerant with the assistance of the components in the air conditioner or refrigeration equipment. For example, the compressor.

(2) Self-contained recovery devices can remove vapor or refrigerant from an air conditioner or refrigeration system without assistance from the units components such as the compressor.

The EPA regulations classify refrigerants into two pressure ranges: high and low pressure.

Low pressure includes, for example, R-11, R-113 and R-123. They boil above 10 degree Celsius at atmospheric pressure 29.9" Hg (29.9 inches of mercury).

High pressure includes, for example, R-12, R-22, R-500 and R-502. They boil at -50 to + 10 degree Celsius at atmospheric pressure 29.9" Hg (29.9 inches of mercury).

QUESTIONS:

1. What years will it not be lawful to vent CFC/HCFC type refrigerants? And HFC type refrigerants?

2. What year was the CAA signed into law?

3. What must be done to dispose of used refrigerant cylinders or vessels?

4. How high can fines be for breaking EPA laws?

5. How high can the reward be for a person reporting EPA law violators?

6. What is the last year that CFC refrigerants will be manufactured?

7. What is the Montreal Protocol Agreement about?

8. What will a recovery device do?

9. What will a recycle device do?

10. What will a reclaim unit do?

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TYPE I SYSTEM SERVICE REQUIREMENTS

OBJECTIVE

4a. Identify Type I refrigeration systems and the service requirements set forth by current EPA regulations by answering a series of questions.

INTRODUCTION

Type I system is one of three types of certification needed to satisfy the EPA and the Air Force's requirements to work on any type of HVAC/R system found in the AFSC and in the industry.

INFORMATION

Descriptions and Certification Requirements for Type I Systems

EPA regulations describe Type I systems as all small appliances manufactured, charged and hermetically sealed. The refrigerant charge will not exceed a total of 5 pounds of refrigerant.

Types of systems that will fall in this category will be domestic and commercial refrigerators, water coolers, dehumidifiers, ice makers, and PTACs to include window and package units containing 5 pounds or less of refrigerant charge. These systems must have a process tube or a straight piece of tubing that may be pierced with an access valve sometimes referred to as a saddle valve or schrader valve.

The only people that will be authorized to service any of the small appliances listed in the previous paragraph are those who possess a valid approved EPA certificate for Type I or Universal Technician after 14 November 1994. After that date, those without the certificate will not be able to recover refrigerants or open any systems and will be in violation of federal law if they do.

Beginning 14 November 1994, only certified technicians will be permitted to purchase CFC or HCFC refrigerants from retail or wholesale distributors.

Once a person has been certified by an EPA approved certification program the law states it will be the responsibility of certificate holders to keep informed and comply with any revisions to the laws and regulations effecting recovery and servicing of any type of refrigeration/air conditioning appliance. **(SEE PAGE 3 YOUR RESPONSIBILITIES)**

Recovery Equipment Requirements and Procedures

Type I and Universal Certified Technicians must be aware of EPA regulations concerning recovery equipment standards for Type I appliances. As of 12 August 1993, anyone using recovery equipment is required to use recovery equipment that meets ARI Standard 740-1993.

15 November 1993 is the date standards changed. Any recovery equipment manufactured prior to 15 November 1993 was required to be capable to recover 80% of the appliance's refrigerant charge or be capable of pulling 4" vac. (4" Hg/4 inches of mercury). The compressor may or may not be operational as outlined under the conditions of ARI 740-1993.

After 15 November 1993, all recovery equipment must be certified by an EPA-approved laboratory. The equipment must have a label that states "**This equipment has been certified by (the name of THE APPROVAL TESTING ORGANIZATION)**. Equipment to meet EPA's minimum requirements for recycling or recovery equipment intended for use with **(the APPROPRIATE CATEGORY OF APPLIANCE)**".

For recovery equipment to be awarded the label described above, it must be capable of recovering not less than 90% of the appliances' charge if the compressor is operating or 80% if the compressor is non-operational. In either case, the recovery system must still be capable of pulling and achieving a 4" vac. (4" Hg/4 inches of mercury) as outlined in ARI 740-1993. The vacuum standard does not change either before or after 15 November 1993.

All recovery equipment must be equipped or retrofitted with valves (low loss fittings) that can be manually closed or devices that automatically close when disconnected from the service hose to prevent refrigerant losses when connecting or disconnecting the unit to the appliance for recovering refrigerant. This requirement applies to all 3 types of systems: Types I, II and III.

You may be surprised to know that it is not mandatory to repair a leak on a Type I or small appliance with a refrigerant charge of 5 pounds or less, but it is recommended it be done very soon, or whenever possible.

Recovery Techniques

As you will note again and again in this study book, **NEVER** mix different types of refrigerants into the same cylinder or vessel. Some reclaim facilities will refuse to process it and will return it to the owner at the owner's expense.

One of the first things that must be done when servicing any type of appliance is to check the appliance to determine what type of refrigerant is inside the system. This information can be found on the data plate on the unit or using the pressure/temperature (PT) chart as discussed elsewhere in this book. Remember to label cylinders with the type of refrigerant that is stored in it. **USE THE PROPER DOT (THE UNITED STATES DEPARTMENT OF TRANSPORTATION) form**.

For Type I appliances, there are two types of recovery systems and they will meet the EPA standards for recovery equipment:

(1) Self-contained recovery equipment which can remove refrigerant from an appliance without the aid of assistance of components contained inside the appliance.

(2) System-dependent recovery which means refrigerant recovery unit that requires the assistance of the components contained in the appliance itself. System-dependent is also called passive recovery.

When using a passive recovery method to remove refrigerant from an appliance, it may be required to heat and strike the appliance sharply several times (to burp the compressor) and/or use a vacuum pump to help release refrigerant trapped in the oil. The refrigerant will be collected in a non-pressurized container. Do not vent the vacuum pump to the atmosphere. It must be recovered.

Remember, never vent a controlled refrigerant to the atmosphere, NEVER!!!

Before installing an access fitting to an appliance, be sure to leak check all access fittings, including both the ones on the appliance and on the recovery unit, to ensure they don't leak by using a refrigerant leak detector. Schrader-type valves should also be inspected to ensure the stem is not bent or leaking. In fact, it is recommended to leak check recovery devices on a daily basis.

When using the passive-system-dependent-process to recover refrigerant from a refrigerator/freezer system that the compressor does not operate, both the high side and low side of the system should be tapped for recovery, to speed up and achieve the required efficiencies to meet current EPA laws. If the system has an electric defrost system, the defrost heaters will be energized since this would also speed up the process of vaporizing any trapped liquid in the system and oil. Another useful tip in getting the refrigerant out of the compressor oil is to send a low voltage of not more than 60 volts AC through the compressor motor windings. This will cause them to get warm, but will not damage them.

If, while installing a line tap service valve, you find that the system has O PSI, the system need not be evacuated. "It's too late". The charge is gone.

Old time refrigerators (Predating the R-12 era) that contained sulfur dioxide, methyl chloride, or methyl formate should not be recovered with current recovery systems. Also, absorption type refrigerators found in campers, etc. should not use current recovery type systems, because these systems contain ammonia, water and hydrogen for refrigeration solutions.

Solder-type line taps are the only recommended access valves designed to be left in systems permanently. Other clamp-on types tend to leak over a period a time because the seals dry out.

Clamp-on type access valves are only recommended when preparing a system for salvage, as the valve can be removed and used over again once all the refrigerant has been recovered in accordance with current EPA regulations. Piercing-type valves are only recommended for use on aluminum and copper tubing.

On a system that has a functioning compressor, a system-dependent recovery system should be used for recovery and the refrigerant should be pulled from the high side into the recovery unit. The same thing will hold true with a plugged cap-tube system that has an operational compressor. A system with this type of problem only requires that only one line tap be installed on the high side somewhere between the compressor and the condenser. The unit compressor will evacuate the system from the restriction through the compressor.

Special care must be taken when using a self contained active recovery unit not designed to take a slug of liquid refrigerant. The refrigerant should be drawn from the high side of the system between the compressor and the condenser.

While operating the recovery system, the technician needs to watch for excessively high operating pressures which could be caused by the inlet valve being left shut or non-condensable, such as air or nitrogen, being compressed in the tank.

Probably the most difficult problem while servicing any refrigeration appliance is "**THE BURN OUT**".

The detection of a pungent odor from a small amount or whiff of refrigerant that might escape during the recovery process indicates a burn out more than likely has occurred. CFC/HCFC refrigerants in small amounts are odorless. When CFC/HCFC refrigerants are exposed to excessive heat from the motor windings that they pass through on hermetic-type compressors for motor cooling, the refrigerant will overheat. Once this occurs, it causes the break down and formation of hydrofluoric and hydrochloric acids due to the moisture released from the refrigerant and oil that also has over heated and has broken down.

For this reason, a burn out contaminated oils must be flushed out of the system and also processed in accordance with EPA laws.

What may be surprising is that after a system has been flushed and purged of all refrigerants, it is permissible, under EPA regulations, to pressurize the system to blow or vent any debris out of the system to the atmosphere using an inert gas.

SUMMARY

Type I systems are small hermetically sealed systems that contain not more than 5 pounds of refrigerant. The EPA does not require that leaks be repaired on the spot. When servicing these systems recovery of the refrigerant is required. Because these systems have such a small charge of refrigerant, the most common method used for recovery will be the passive recovery systems which are nothing more than special cylinders that only have to be evacuated and/or chilled to draw the refrigerant from the appliance. In some cases a specially designed plastic bag is used
to hold refrigerant until it can be recovered by powered recovery systems back in the shop.

General Refrigeration

The EPA has determined you must understand refrigeration in general and it is for this reason we will be covering these refrigeration subjects. Most of these subjects you are already aware of but, it will not hurt to review them.

The MGA (manifold gauge assembly) consists of 2 gauges. A high side and a low side gauge (compound gauge). Generally, the high side gauge will be color-coded red and the low side gauge will be color-coded blue.

The low side (compound) gauge will have increments of PSIG for pressures above O PSI and inches of mercury (" Hg) for measuring vacuums.

The high side gauge will have increments from 0 to 500 PSI. Even though some high side gauges will show a vacuum scale, it is not used to measure vacuums. This part of the gauge is only there to protect the pointer from being thrown out of calibration if the gauge is exposed to vacuum pressures.

The manifold will have 3 ports to connect service hoses. The port on each end of the manifold will be used to take readings of the high and low side of a system while the center port is used for recovery, charging and evacuation of a system. Be careful when using the MGA with a vacuum pump. The pressure reading will not be accurate unless the gauge is connected to the low side service port away from the vacuum pump itself.

The Refrigeration Cycle

During the refrigeration cycle, refrigerant changes state twice. Once in the condenser, where a high pressure vapor is turned into a high pressure liquid, then, as it passes through the receiver, especially if the system uses a TXV (thermostatic expansion valve), it continues on to the liquid line to the expansion device or metering device.

Once the liquid passes through the metering device on a system with a direct expansion type evaporator the high pressure liquid changes to a low pressure liquid and vapor (this is the second time that the refrigerant changes state in the refrigeration cycle). As the low pressure refrigerant boils off in the evaporator, it turns into a saturated vapor. If the system requires one, the refrigerant goes to an accumulator before going to the compressor.

A saturated refrigerant is liquid refrigerant and refrigerant vapor that is the same temperature. Refrigerant can only become superheated when all the liquid has boiled away and additional heat is added to the remaining vapor.

As the refrigerant passes back to the compressor, the low pressure superheated gas or vapor will enter the compressor where it is compressed and becomes a high pressure gas or vapor again before entering the condenser to start the cycle again.

Service Tips

The following are some service tips that are good rules to follow:

* Check the moisture indicating sight glass, if a unit has them, to determine the quality of refrigerant for moisture or water content and system charge.

* Recover or recycle refrigerants. ALWAYS

*	Keep a system tight "FR&S" (Find, Repair & Stop the Leak).

*	Never operate any hermetic or semihermetic compressor when there is a dehydration vacuum on the system, without refrigerant cooling the compressor, it will burn up.

*	Whenever a system is opened for servicing or replacing a system component, the filter dryers should always be replaced to protect the system from moisture and foreign particles that may have been left in the system.

A common problem that service technicians will encounter with some compressors operating in/or with low operating temperatures, is that refrigerants can migrate to the crankcase of the compressor because of the vapor pressure difference between the oil and the refrigerant. The best way to overcome this problem is to install a thermostatic controlled crankcase heater.

A good way of knowing if refrigerant has migrated to a compressor crankcase is that the oil will foam. The liquid (refrigerant) begins to boil off because of the agitation caused by the moving parts in the crankcase and the pressure differences as mentioned before. If the crankcase has a sight glass you will see the foaming, if it does not have one sweating or frosting of the crankcase is a dead give-away.

While servicing most type of air conditioning package system,(PTAC s), you might expect to find it charged with R-22. However, not all systems use R-22, but all systems should or will have a data plate. The data plate will contain important information that a technician is required to know before starting to work on any system. The data plate should include, voltage, phases of power, locked, full load and running amps, allowable machine test pressure, type of charge and the amount of charge.

If the type and amount of charge is stated, then the system should be charged by charging liquid through the liquid line service valve. Large systems will have a charge port on the king valve at the beginning of the liquid line.

Many refrigeration service technicians normally relied on their manifold gauges in the past while pulling vacuums on refrigeration systems but, as mentioned before, the compound gauge will give readings in inches of mercury. These readings are not very accurate when low or deep vacuums are required. The vacuum will need to be measured in microns. For example, when pulling a vacuum on a vapor compression system a vacuum pump will have to be capable of pulling down to at least 500 microns. Most vacuum pumps will use an electronic device that has this capability.

Service technicians must also remember that air is a noncondensable gas and if it gets into a refrigeration system it will cause high discharge and suction pressures. To prevent this from happening the suction service valve must be back seated closing the gauge port. Once the service hose has been removed, the port needs to be sealed with a cap designed to prevent air from leaking in or refrigerant from leaking out, whatever the case may be.

As old timers already know, R-12 gauge pressure readings and saturated or boiling temperatures are very close to the same. For example, for R-12, the numbers on a pressure/temperature chart between the temperatures of 20 degs. F. to 75 degs. F. are within a few points of each other.

So, if you were charging a system that had been previously evacuated with liquid R-12 and a freezing temperature could cause some sort of damage, you should charge a vapor into the system raising the system pressure to 33 PSIG or more. This would eliminate the possibility of freezing as 33 PSIG on a PT chart is equal to 33 degrees F. (water freezes at 32 degrees F.)

If you were on a service call and you found a green-colored throw away refrigerant cylinder sitting in the mechanical room and you knew that all of the condensing units are charged with only R-12, you might be suspicious as to what type of refrigerant is in the cylinder.

How would you find out if someone used an unlawful procedure to transfer refrigerant into a non-refillable cylinder and what type of refrigerant was in the cylinder?

1. Take the room temperature and cylinder temperature if possible. (They should be the same).

NOTE: PRESSURES AND TEMPERATURES OF THE CYLINDER MUST BE STABLE

2. Connect a high side gauge to the cylinder.

3. Open the cylinder and check the PT chart on your gauge.

4. See if the pointer lines up with any refrigerant that matches the room temperature, you have identified the refrigerant.

For example with a room temperature of:

72 degrees F. R-12 the pressure should be 74 PSIG
75 degrees F. R-12 the pressure should be 75 PSIG
72 degrees F. R-22 the pressure should be 127 PSIG
75 degrees F. R-22 the pressure should be 130 PSIG
72 degrees F. R-502 the pressure should be 146 PSIG
75 degrees F. R-500 the pressure should be 95 PSIG

If the pressures are OFF more than 3 PSIG off, you should suspect the refrigerants have been mixed.

NOTE: STUDY THE PT CHART IN THE BACK OF THE BOOK

While servicing a system and you are trying to determine if it is producing the refrigeration effect as it was designed to do you would have to plot the systems performance using a PE (pressure enthalpy) chart.

To use a PE (pressure enthalpy) chart, you will be required to convert your gauge pressures from PSIG to PSIA as PE charts are based on using PSIA.

Most mechanics will only have common MGAs designed to give only PSIG readings, so to convert PSIG to PSIA you will have to add 14.7 PSI to what ever gauge reading is.

For example, if you are reading 20 PSIG add 14.7 PSI and you come up with 34.7 PSIA. To plot the PE chart draw a line across the chart at 34.7 PSIA indicated on both sides of the chart. The line will cross over the saturated temperature curve in the center of the page this will give you the saturated temperature that you are looking for.

But if you were required to find what the saturated temperature of a refrigerant was and you only had a standard pressure/temperature chart and you know what the PSIA is, then you must do the opposite of what was stated in the previous paragraph.

For example, if a system charged with R-134a had an evaporator pressure of 14.7 PSIA you must subtract the 14.7 PSI which would give you 0 PSIG. When converting the 0 PSIG to temperature using the PT chart, you will find that it converts to a saturated temperature of -15 degs. F.

To plot a PE chart you will be using both gauges and a thermometer to gather the information to determine the systems performance factor. The temperature readings are plotted without any computations. Why? They are taken externally and atmospheric pressures have no effect on them.

One of the most complicated systems for a technician to service is the multi-compressor multi-evaporator system. It is difficult to identify the malfunctioning component because these systems use common discharge, suction, and liquid lines.

The compressors will require 2 equalizer lines connecting the multiple compressors. There will be an oil equalizer line between each compressor that must connect the bottom of each compressor crankcases to insure an even oil level between compressors. Most systems will also have a second equalization line installed on the compressor crankcases but, at the top part of the crankcase to equalize the vapor pressures between the compressors.

Some multi-compressor systems will use a common suction line manifold in place of a crankcase vapor pressure equalization line. While troubleshooting these types of systems, if one of the compressors is not pulling its fair share of the load the other compressor(s) will hide the problem. The only way to detect and find the problem is to isolate each compressor and perform a performance test on each compressor.

Another major problem with these systems is that because of the open equalization line(s) the refrigerant cannot be recovered without isolating the parallel compressors because of cost and the possibility of a service technician forgetting to open them after servicing the system. This could cause oil starvation and compressor failure.

QUESTIONS:

1. What is the maximum amount of refrigerant charge that Type I systems contain?

2. Who will be authorized to purchase refrigerants in the future?

3. What documents states the recovery standards for System I appliances?

4. What is the date that new recovery standards for Type I recovery systems went in to effect?

5. All recovery equipment/devices manufactured today must be equipped with what type special devices to prevent refrigerant losses?

6. What is the current requirement for repairing leaks on Type I systems today?

7. What will happen if you turn in recovered refrigerant for recycling that has been mixed?

8. What are the 3 types of recovery systems used for the recovery of refrigerants in Type I systems?

1

2

3

9. What type of refrigerants should not be recovered with equipment that has been used to recover CFC/HCFC refrigerants?

10. When is the only time the law will permit purging the contents of a refrigeration system to the atmosphere?

TYPE II SYSTEM SERVICE REQUIREMENTS

OBJECTIVE 5a

Identify Type II refrigeration systems and the service requirements set forth by current EPA regulations by answering a series of questions.

INTRODUCTION/INFORMATION

Type II Systems

Type II systems under the EPA Universal Certification Program will include all high pressure and very high pressure systems not covered under the Type I Systems. Under the Universal Technician certification program this will include MVAC-like systems and all other systems with more than 5 pounds of refrigerant charge. Type II systems will include hermetic and open type compressors (no matter what type of power drive), direct expansion and indirect expansion systems, PTAC and split systems.

Technicians that want to work on and service MVAC and MVAC-like appliances must be certified under section 609 of the Clean Air Act. Technicians that are certified under section 608 of the Clean Air Act may only service MVAC-like appliances but if this is their prime job the EPA recommends they be certified under section 609.

Recovery System Maintenance

The recovery process on Type II systems is somewhat more complex because these systems contain large amounts of refrigerants and the passive recovery methods used for System I systems are not designed to remove large amounts of refrigerant. Passive recovery systems will not be used on systems with more than 15 pounds of charge.

Type II systems, besides being much larger, also consist of many designs. On Type I systems, all of the refrigeration components are located in a single unit, where as Type II systems can have the compressors in one location, condensers in another, the receivers in still another, and evaporators in several other locations. All of this can create different problems that require different solutions to recover refrigerant and other contaminants from the systems.

Still, most of the procedures covering recovery practices under Type I will not change for Type II systems.

TYPE II RECOVERY SYSTEMS REQUIREMENTS

1. **NEVER** mix refrigerants.

2. Before using an empty storage cylinders or vessels, it should be evacuated.

3. Service hoses and recovery, reclaim, or recycle units require either hand valves or automatic/quick closing valves to prevent refrigerant loss during the connecting and disconnecting process.

4. Recovery, reclaim, or recycle units should be leak checked often/or every day it is used.

5. Before operating a recovery system, check the service valve positions, oil level and evacuate the recovery unit receiver and/or other recovery cylinders when recovering large quantities of refrigerants.

RECOVERY UNIT MAINTENANCE

Recovery units used for Type II systems will be self-contained recovery system and will require constant maintenance.

1. Oil and refrigerant filters will require changing often because of contamination. Contaminated oil and filters will have to be processed also in accordance with EPA regulations.

2. When switching to a different type of refrigerant and using the same recovery, recycle or reclaim unit, before the evacuation, the compressor oil, and refrigerant filters must be changed. If the system still has some of the original refrigerant in it that refrigerant must also be removed before evacuation process is started.

3. HCFC/CFC recovery equipment must include hoses, gauges, vacuum pumps, oil storage containers, and recovery cylinders.

EPA Standards and Recovery System Limitations

Recovery units can only be used to recover one type of refrigerant at a time. As stated earlier, when changing from one type of CFC or HCFC to another, special procedures must be followed. HFC recovery equipment and associated tools must never be used on CFC/HCFC appliances.

15 November 1993, was the date that more stringent recovery equipment requirements came into effect for all types of recovery recycling systems used for Type II and Type III systems.

STUDY THE CHART ON PAGE **viii** - IN THE FRONT OF THIS BOOK. IT CONTAINS THE REQUIRED LEVELS OF EVACUATION FOR ALL TYPES OF SYSTEMS FOR THE BEFORE AND AFTER 15 NOVEMBER 1993 DATE.

The one instance that a technician would not be held to the requirements listed in the chart would be if an appliance had a system leak so great that recovery or reclaim unit is unable to achieve required vacuum standard. The reason for this is that by trying to achieve the required vacuum, the refrigerant that was recovered would be contaminated with air and moisture thus requiring reclaiming or recycling.

The EPA regulations classify any major repair as a repair involving a major component in the system. For example, replacing an evaporator, condenser, compressor, or receiver. Replacing a filter drier, strainer expansion valve, or other minor component would not be a major repair. Replacing condenser or evaporator fans or blowers or any other electrical component is of no concern to the EPA as long as it has no effect on the refrigerant charge.

One word of caution, a service technician must be aware of self contained recovery or reclaim units. Some of these units will use hermetic-type compressors, these type compressors require refrigerant for motor cooling. So as the appliance begins to draw down into a vacuum, refrigerant flow will decrease. Prolonged operation under these types of conditions will shorten the life of the compressor motor and in time will cause the unit to burn out. Open drive compressors are not prone to this problem as the motors do not require refrigerant to flow through them for cooling therefore are not exposed to the other problems such as moisture and acids that recovered refrigerants can contain.

Some units will also have water cooled condensers that have water connections for common city water which can be connected with common garden hoses. These type systems are far more efficient for use on larger appliances because of the better condensing factors when using water rather than air for cooling.

Recovered refrigerant always has the chance of containing acid, moisture, and oils. It is for this reason that recycle units are more effective as recovery systems. They are designed to remove these items. Even though they will not return the refrigerant to new conditions, they will provide additional protection to the system by returning the used refrigerant to the appliance in a cleaner or more pure state than it was when it was extracted.

Recovery Techniques

Because of the large variety of Type II refrigeration systems, the service technician will be required to use one or several recovery techniques to recover and evacuate these systems to satisfy EPA requirements.

Not in all cases is it required to recover/remove refrigerant from a system. If a system has pump down capability by using the receiver or condenser and isolation valves such as a king and or compressor service valves the system may be used as a recovery unit. This is a type of system dependent recovery system.

You must be sure that the part of the system that is to be opened must never have a positive pressure above 0 PSI to insure that refrigerant does not leak out to the atmosphere. The following page are the procedures that should be followed if using these method of recovery.

PUMP DOWN SYSTEM RECOVERY METHOD

1. Install a MGA. Close the king valve and pump the system down to 10” HG.

2. Close the service valve on the low side of the compressor by front seating it. Watch the compound gage(low side gage)

3. If the pressure rises above 0 PSI, open the suction service valve (port) by back seating it a few turns and repeat the procedure. This will pump out any refrigerant that may have been trapped in the system.

4. If the gage pressure continues to rise above 0 PSI then this indicates that the service valves or king valve are leaking and the whole system charge will have to be removed before the system is opened to the atmosphere.

SYSTEM PRESSURE MUST NEVER BE PERMITTED TO RISE ABOVE 0 PSI WHILE IT IS OPEN

((((**OTHERWISE THE SYSTEM IS VENTING AND THIS IS AGAINST THE LAW**))))

When removing the refrigerant charge from a system, to most technicians, time is critical. In many cases, the recovery process can take hours and, in some cases, days to achieve evacuation levels required to satisfy EPA laws. But there are ways to speed up the process.

Whenever possible remove as much refrigerant from the appliance in a liquid state, sometimes referred to as the liquid phase. A disadvantage of this method is that refrigerant oil can be drawn out of the system along with the liquid refrigerant. That oil will have to be replaced. The old charge should be returned to the system by the same method as it was removed. If new refrigerant is used when recharging the system then new oil must added.

Removing the refrigerant in a liquid state can be done by tapping into the liquid line of the system and drawing the refrigerant into an already evacuated recovery storage cylinder or the recovery system receiver. Once all the liquid refrigerant has been removed, then use the compressor on the recovery unit to compress and remove any remaining vapor in the system, pressurizing and condensing the vapor, as it is passed on to the storage cylinder. Continue the evacuation process until all the refrigerant has been removed and the proper vacuum achieved.

Once the proper vacuum has been achieved, the recovery unit valves should be closed to isolate the recovery unit from the appliance. Then, watch the gauges or vacuum meter to see if the pressures rise. Give the appliance a few minutes to react. If the pressure rises rapidly, it indicates air and a leak is present. If there is a slight rise and the pressure holds, this indicates moisture and dehydration needs to be continued.

When removing liquid refrigerant from a system, the hose going to the recovery unit should be installed at the lowest point in the system where liquid will settle. For example, if the receiver is lower than the condenser, then the outlet of the receivers should be used. However, if the condenser is lower than the receiver, then the hose should be connected to the bottom of the condenser outlet, never to the top.

Some appliances will have a service valve installed somewhere in the system on the high side for the sole purpose of charging and removing liquid refrigerant. To aid in quicker recovery of refrigerants and to reduce the head pressures on recovery or recycle units, pack or immerse the recovery cylinder in ice or ice water. This will speed up the removal process. There are commercially manufactured or home made refrigerated chiller tanks designed to chill recovery cylinders for this purpose. Care must be taken when using these type of recovery aids. DO NOT OVER FILL THE CYLINDERS.

To remove oil from a refrigerant charged appliance the compressor crankcase pressure must be evacuated/pressurized to not more than 5 PSIG then the oil may be recovered into a sealed container or drain oil into a system receiver to be evacuated/pressurized to a pressure no greater than 5 PSIG. **THIS PROCEDURE WILL GREATLY REDUCE REFRIGERANT EMISSIONS WHILE PERMITTING A SLIGHT POSTIIVE PRESSURE TO FORCE REFRIGERANT FROM THE COMPRRESSOR/SYSTEM RECEIVER. IT IS A VIOLATION TO CHANGE/REMOVE OIL AT A HIGHER THAN 5 PSIG PRESSURE. (EPA SECTION 608 RULE CHANGING REFRIGERANT OIL OCTOBER 1995.)**

QUESTIONS:

1. What type of refrigeration systems will fall under the Type II Universal Technician certification program?

2. What is the maximum amount of refrigerant charge that a passive recovery system may be used for to recover refrigerant?

3. Before using an empty storage or recovery cylinder or vessel, what must be done?

4. What service requirement should be performed prior to using any recovery or recycle unit?

5. What service requirement is required when going from one type of refrigerant to another type such as R-12 to R-22 when using the same recycle unit?

6. After 15 November 1993 recovery equipment will be required to pull________________" Hg.

7. What is the only exception to the 15 November l993 evacuation standard?

8. List 3 major repairs for refrigeration systems as classified by EPA.

   1.

   2.

   3.

9. Why do some recovery/recycle units have water cooled condensers?

10. What is a quick method for recovering large amounts of refrigerants from large refrigeration systems?

TYPE III SYSTEM SERVICE REQUIREMENTS

OBJECTIVE 6a

Identify Type III refrigeration systems and the service requirements set forth by current EPA regulations by answering a series of questions.

INTRODUCTION

The air conditioning equipment found in the Type III category is totally different from anything that has been covered up to this point. These systems are very large and can vary in capacity from about 80 tons to 10,000 tons of cooling capacity.

They are indirect expansion type systems that will send chilled or conditioned water out to air handlers that have coils in them that will cool the air passing over them.

These systems will be charged with hundreds of pounds of refrigerant with larger appliances charged with thousands of pounds of refrigerant in them.

INFORMATION

Type III Systems

Type III systems are low pressure systems. They operate in very deep vacuums and are in a vacuum whenever they have refrigerant in them. Type III systems also include industrial process equipment used in industrial manufacturing processes and ice plants.

A leak on these systems means refrigerant does not leak out, but air and water leaks in and in time the appliances pressures will rise causing positives and refrigerant leaks. This is the number one problem with this type of system.

To illustrate this, the high pressure safety cut out on Type III systems is set to stop the unit when the head pressures reach 8 to 10 PSIG. The low side pressures can run from 20 to almost 30 inches of mercury it is for this reason, the EPA calls these systems low pressure systems.

Centrifugal Air Conditioner Operation

These systems will have two water circuits. One will be to the condenser. This is called a tube-and-shell type condenser. Condenser or cooling tower water will flow through the tubes inside the shell. The refrigerant will flow around the tubes giving up its heat to the water flowing through the tubes.

An evaporator is constructed the same way, using the tube-and-shell construction with the only difference being the water is what is called chilled water or is also known as a secondary refrigerant and it flows through the tubes where it gives up its heat that was picked up in the air handler coils cooling the rooms in the building to the refrigerant flowing around the tubes.

The evaporator will be located below the condenser with the compressor located between them.

During the off cycle, when the unit is shut down, the pressures will be the same throughout the system since there are no valves inside these systems. The refrigerant will migrate and settle in the bottom of the evaporator, the lowest part of the system.

As previously stated, these systems don't generally leak out, but leak in. For this reason, the primary purpose of the systems factory installed purge unit is to evacuate and purge air and non-condensable from the system and in the process this maintains the proper vacuum on the appliance required for successful operation to provide the proper operating evaporator and condenser pressures.

NOTE: THE PURGE UNIT IS NOT A RECOVERY SYSTEM

The purge unit will automatically return recycled refrigerant to the system and purge non-condensable (that were trapped in the top of the condenser) out of the system.

Generally, any water that the purge unit removes from the refrigerant will be drained manually. The unit draws the refrigerant for reclaiming from the top of the condenser. The purge unit is generally, always found sitting on top of the condenser where it draws the contaminated refrigerant vapor. The reclaimed liquid refrigerant which was condensed in the purge unit is returned to the evaporator at the bottom of the system.

The EPA has mandated that purge units to day must meet higher evacuation standards and also have recovery cylinders to capture the non condensable vapors purged from the system as these new systems still purge small amounts of refrigerant with the non-condensables.

Centrifugal air conditioners have another device called the rupture disk. It is a brass sheet (membrane) that is only a few thousandths of an inch thick and is designed burst at a pressure of 15 pounds. These disks will be installed above the liquid level line in the evaporator for good reason. If the disk were to burst, the pressure in the system would fall quickly to atmospheric pressure dumping huge amounts of liquid refrigerant. Normally, mechanical rooms are very warm, 80 degs. F. or higher. (NOTE: R-11 will boil at 74.5 degs. F. at atmospheric pressure or 14.7 PSIA.). With the high temperatures found in boiler rooms, system temperatures would rise, permitting the refrigerant to boil and to be lost if left undetected for sometime.

To charge or add refrigerant to a centrifugal or low pressure appliance, it will be charged by way of the evaporator charging valve which is located on the bottom of the evaporator the lowest point in the system.

This valve will also be used for removing the refrigerant when pulling it out in a liquid state for the recovery process.

The industry is trying to replace the CFCs R-11 and R-113. They have come out with a replacement refrigerant HCFC R-123 which has a very close proximity to the other refrigerants in operating pressures and temperatures. HCFC-123 is expected to be phased out completely by 2030.

For example, at 32 degs. F., R-123 will have a corresponding pressure of 20" Hg (20 inches of mercury) while R-11 at the same temperature will have a pressure of 18.1" Hg. These pressures are very close to each other and as you can see these systems operate in a deep vacuum.

Current R-11 and R-113 systems can be refitted to operate with R-123, but it is quite costly.

Leak Detection

As mentioned earlier, liquid chillers are Type III appliances. When they have a leak, the leak is a "leak in" rather than a "leak out" due to the fact that these systems operate in deep vacuums.

Now, how do you find the leak if you can't get inside the machine? The answer is the machine or appliance will have to be pressurized in some way.

Like all of the other systems, nitrogen is one answer, but care must be taken. The rupture disk is set to burst at 15 PSI. Thus, pressure must not be exceeded when pressurizing a centrifugal AC unit. The maximum pressure that the nitrogen pressure regulator should be set is, around 10 PSIG. This way there will be a safety buffer that will protect the rupture disk and the tubing bundles in the evaporator and condenser of the system.

In order to leak check the tubes in the evaporator and/or condenser, you will want to make sure that is where the leak actually is in the first place.

Most often, moisture enters the chiller through areas that have gaskets or other type fittings. The tube and shells of evaporators and condensers are unitized, welded, and factory sealed. Rarely do they leak.

But sometimes bundles do develop leaks, especially if the, unit is old and water treatment has been lax.

If the tubing bundles are suspected of having leaks, do not tear the end bells or water boxes off the ends of the condenser or evaporator to check the system. Open the drain valve or remove the drain plug and drain the water from the component. After the water has drained, pressurize the system not to exceed 10 PSIG, with nitrogen and use a leak detector for testing to see if any refrigerant is coming out of the drain. If there is refrigerant, then the end bells or boxes will have to be removed on the component that is leaking and each tube tested individually to locate the leak.

If there is only one or a few tubes that have leaks, there are special devices available to plug and seal the tubes. After this has been done, the system must be leak tested again before being put back together and on the line.

The machine then needs to be scheduled for retubing in the near future to prevent the problem from reoccurring. There is a hydrostatic tube test that can be used to test each of the tubes to see if they are tight and are leak free.

The most effective method of leak detection on a system that contains a refrigerant charge is to use a controlled hot water system. However, extreme care must be used to maintain system pressures at or below 10 PSIG. The use of heat blankets/pads or lamps is also another approved method used to raise system pressures.

The EPA now requires all purge units to conform to higher standards than in the past. Purge units, as you know, are designed to remove non-condensable from the system. However, in the process of purging the non-condensable, they would also let some refrigerant go also. If the pressure relief device or purge unit became defective, it is possible they could dump or purge the whole charge in the system. To prevent this from happening, the purge vent should be piped to a recovery unit where the refrigerant would be captured.

Leak Repair Requirement

The EPA has set two standards as to when refrigerant leaks must be repaired. However, you should try not to wait until the leaks are so bad that repairs become necessary.

There are two simple standards.

1. In all appliances charged with 50 pounds or more of refrigerant, excluding commercial and industrial process refrigeration (Ice Plants/Manufacturing), the leak rate will not exceed 15% of the systems total charge per year. For example, a system that contains 100 pounds of refrigerant that lost 12 pounds in one year, would not require the leak to be repaired. But if the same system lost 16 pounds, it must be repaired. However, keep in mind, all leaks should be stopped and repaired as soon as possible.

2. Industrial and commercial process refrigeration systems that have a leak that exc35% of the charge in 1 year must be repaired. For example, if an industrial IcePlant contained a charge of 200 pounds and it lost 65 pounds of refrigerant in 1 year, it would not have to be repaired, but if that same system had lost 75 pounds, it would have to be repaired. Again, any leak should be repaired as soon as possible.

NOTE: A system scheduled for replacement does not require repairs if the replacement is completed in the time outlined in the EPA regulations.

Let there be no doubt there are ways to find out about leaks because of laws now in place. Refrigerant purchases and consumption's must be documented and when 1 + 1 don't add up to 2, the inspectors will find out why. You will recall the EPA inspection program that was mentioned in the orientation part of this study book also includes this.

The EPA has also set two standards for recovery and recycle units used on low pressure appliances. These standards are to be used when major repairs are required and the appliance must be evacuated.

1. If the unit was manufactured before 15 November 1993, it had to be capable of pulling 25" Hg (25 inches of mercury).

2. After the 15 November 1993 date, it must be able to pull 25mm Absolute.

Recovery Techniques

The recovery techniques for low pressure systems are similar to both Type I and Type II systems, but are on a larger scale. The recovery vessels and unit for Type III systems will be quite large, each vessel or cylinder can hold upwards of 5,000 pounds of refrigerant for each cylinder connected to the recovery, recycle, or reclaim unit.

Before starting the recovery cycle, check your equipment for leaks, that the valves are in the proper position, and that the water hoses (if the recovery unit uses water cooling for the condensers) connected to the city or tap water have been properly connected. The high pressure cut out on the recovery unit must **NOT** be set above 10 PSI, because the rupture disks on the storage or recovery vessels are designed to burst at 15 PSI, the same as the appliance.

After everything has been checked, start the liquid removal process. This means pulling the liquid from the evaporator charging valve on the bottom of the evaporator.

You will continue this process until as much liquid as possible has been removed from the system.

NOTE: Even though you have the system down to 0 PSIG, there could still be several hundred pounds of vaporized refrigerant in the system. For example, the average 350 ton unit that has an R-11 charge will still have 100 lbs or more of vapor left in the system after all the liquid has been removed. On larger systems, this figure would rise to several thousands of pounds of vapor. In this book under **SAFETY**, it discusses how refrigerant vapor is much heavier than air.

Now that the liquid refrigerant has been removed, the system water pumps (chilled water and condenser water) must be activated and water circulated through the system. This is required to prevent standing water in the tubes from freezing as the systems pressures begin to drop. Also at this time, water should be flowing through the recovery condenser and the recovery unit compressor operating.

The oil heater located in the oil sump on the appliance should be turned on so that refrigerant trapped in the oil will be boiled out, so the recovery unit can capture it. The thermostat should be adjusted to maintain the oil at 130 degs. F., so when the oil is removed, most if not all of the refrigerant will have been boiled out and the oil will be relatively refrigerant free.

The evacuation process should continue until the system has pulled down to 1mm Hg (1 millimeter of mercury). The technician should let the system stand a few minutes to see if the pressure rises. This will determine if there is liquid refrigerant in the system and/or in the oil.

To perform a standing vacuum test, the system should be let stand and watched to see if the pressure will rise. A pressure rise of more than 2.5mm Hg (2.5 millimeter of mercury) indicates a leak and the appliance must be leak checked and according to ASHRAE guideline 3 - 1990.

It should be noted that it is not always necessary to recover the refrigerant from a low pressure system, this procedure is required only for major maintenance or repair. For example, it would be considered a major repair any time the system had to be opened up to replace or repair a hermetic motor that had failed, impellers needing replaced, or (evaporator/condenser heat exchanger) tubing bundles in need of replacing. Anything that could cause the refrigerant to spill or leak out of the system is a major repair item.

Minor repairs could be anything where a component is mounted externally and can be isolated from the system such as a purge unit, oil filter, or a pressure control among other things.

In this case, the unit will be shut down and that component isolated and repaired after it has been evacuated. When the repair is completed, the component should be evacuated before opening it back to the system.

If that is not possible, EPA regulations state that using heat blankets/lamps or controlled hot water may be used to raise the refrigerant temperature to raise the system pressure to perform the minor maintenance. Special care must be used, so refrigerant vapor does not escape. The system pressure should be raised to atmospheric pressure (0 PSI) to prevent refrigerant from escaping and air from entering the system.

Charging

Charging a low pressure system has its problems unlike most high pressure system. Freezing temperatures of the refrigerant as it re-enters the system could cause the water inside the tubes to freeze.

To prevent this from happening, the refrigerant should be put back into the system just the reverse of how it was taken out.

Although, before we start putting refrigerant back in, it would be an excellent idea for heat to be applied to the storage cylinder to heat the liquid refrigerant. This will speed up the process of charging the system.

WORD OF WARNING! Do not over heat the recovery cylinders. Remember, raising the pressure inside of the cylinder would cause the rupture disk to burst.

The vacuum on the chiller (appliance) should be broken with vaporized refrigerant. The chiller is in a very deep vacuum of 29" Hg. This is well below 32 degs. F., the freezing point of water. If liquid (R-11) were to enter the appliances' huge cavity at such a low pressure that the refrigerant would flash off very quickly. In fact, it could freeze the water in the tubes on contact. To prevent this problem, refrigerant vapor should be charged first, to raise the pressures inside the chamber until it rises to an above freezing pressure to a safe level of 36 degs. F. or 16.9" Hg. It may take several hundreds of pounds of refrigerant to achieve this safe pressure and temperature.

Once the vessel or appliance pressure has been raised above the danger zone (freezing), the procedure should be changed to liquid charging by way of the evaporator charging value.

When charging these type of systems the manufactures manual must be followed because every system is different.

Safety

As we come to the last subject of this unit of study, it should not surprise anyone that the subject is safety. Its an important subject as stated before and could **SAVE YOUR LIFE!**

CFC, HCFC, and HFC refrigerants fall into different code groups. Group A being the safest non-explosive and non-toxic. Non-toxic does not mean non-fatal. Anything that has the ability to remove air and oxygen in a closed space will kill.

Refrigerants in group B are toxic and will cause irritation and health problems.

The number after the grouping letter will indicate what level of flammability the refrigerant has been assigned.

This scale of Code Group has been established under ASHRAE Standard 34. For example, R-134a, R-11, R-12, and R-22 are group A-1, while R-123 the replacement for R-11 is group B-1.

Because of the higher toxic rate of R-123 and the huge amount of refrigerants that low pressure systems require, ASHRAE Standard 15 requires that a refrigerant sensor be installed for safety. However, R-12, R-134a, and R-11 under the same ASHRAE Standard require equipment oxygen deprivation sensors because, they fall into the A-1 group.

If a leak is present in the B-1 group, the sensor will pick it up. Although, in the A-1 group, the lack of oxygen will be picked up by the sensor.

The rest of the safety rules are up to you. The sensors outlined in the ASHRAE Standard are the responsibility of the owner of the facility.

Now that you are aware of the law, don't forget it is part of your responsibility to help enforce it. Inform your supervisor if the law is being violated and in most cases, they will take care of it. Remember, its still up to you if you want to take your life into your own hands.

SAFETY TIPS TO FOLLOW

* Good work habits are key to safe work.

* Avoid spilling liquid refrigerant onto the skin (low pressure refrigerants are deceptive).

* Never siphon refrigerant by mouth, they are poisonous and dangerous if swallowed.

* Refrigerants are very heavy and the cylinders are difficult to move, use the proper equipment when moving the cylinders.

* When working with refrigerant cylinders and recovery equipment, ensure that the equipment is secured and will not rollaway, tip over or fall. Refrigerant could be released to the atmosphere and worse, it could be you that the equipment falls on or rolls over.

* Lastly, remember all the safety lectures that you have attended and articles that you have read and follow them.

QUESTIONS:

1. What type of refrigeration appliances fall under the Type III certification program?

2. What type of leaks are most common with low pressure systems?

3. What function does the purge unit serve on a centrifugal system?

4. How are the evaporators and condensers constructed on centrifugal systems and where will they be located in the system?

5. Which part of a centrifugal system are the noncondensables drawn from?

6. What function does a rupture disk serve on a centrifugal system and where will it be located?

7. Describe the proper method for charging a centrifugal system?

8. What type of refrigerants will be used in low pressure centrifugal systems?

9. Today, what percent of a system's total charge will trigger the requirement that it must be repaired? On systems less than 200 pounds? Over 200 pounds per year.

10. Recover/recycle equipment used for low pressure appliances if manufactured before l5 November l993 must be able to pull________" Hg and if manufactured after l5 November l993 it must be able to pull mm Absolute.

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LEAK DETECTION PROCEDURES

OBJECTIVE 7a

Identify proper leak detection procedures by answering a series of questions.

INTRODUCTION

Procedures for leak detection have changed because some of the old methods of pressurizing systems caused CFC and HCFCs to escape to the atmosphere which is not legal or lawful anymore.

INFORMATION

The New Refrigerants

At this time, the EPA DOES NOT RECOGNIZE ANY OF THE NEW REFRIGERANTS NOW ON THE MARKET AS DROP IN REFRIGERANTS FOR R-12. That is not to say that there will not be one some day. At the time of this printing there are none, but the EPA has approved several new refrigerants as NEAR DROP IN refrigerants.

Most of the new refrigerants that will be replacing the soon-to-be-banned HCFC and CFC are Azeotropic or Ternary blends of refrigerants. AZEOTROPIC mixtures are two refrigerants mixed to create a third refrigerant with its own individual characteristics. A TERNARY blend refrigerant is a three part mixture forming a single refrigerant. One problem that a ternary refrigerant blended refrigerants have is called TEMPERATURE GLIDE.

Temperature glide means as the refrigerants passes through the condenser or the evaporator, the boiling and condensing pressures and temperature tend to glide rising or falling as the blend of refrigerant moves through the component. Because of this, these refrigerants must always be charged as a liquid never as a vapor.

Leak Detection

Refrigerant leaks on systems charged with these new ternary blends will be uneven due to the different vapor pressures caused by the glide.

Systems charged with HFC R-134a can be leak checked with pressurized nitrogen.

It should be noted that R-134a does not have the chlorine that causes damage to the ozone layer. For this reason, it is the only refrigerant of this form of leak detection that is permitted.

Because of this temperature pressure glide, these systems should be charged using the weighted method only, by charging liquid refrigerant into the high side of the refrigeration appliance (system) only.

Some of the current or old methods of leak detection are still the most effective methods of leak detection. For example, a system that has a small leak in a general area, the electronic/ultrasonic detector is the most effective.

One of the main disadvantages with the old halide leak detector is use of an open flame and a hot glowing metal surface. This causes R-12, R-22, and other HCFC and CFC refrigerants to decompose and form hydrochloric, hydrofluoric acids, and phosgene gas, which is poisonous to inhale.

If a system has lost its complete charge, it should not be pressurized with a pure refrigerant. It should only be pressurized with dry nitrogen or using R-22 as a tracer refrigerant in combination with dry nitrogen and then checked with a detecting solution, electronic detector, or dye.

Looking for oil traces or residue also indicates the location of leaks on all open-type compressors. Always check the shaft seal on an open-type compressors where the crank shaft comes through the compressor housing. This is where it usually leaks. The failure of a system to hold a vacuum after being evacuated indicates that the system has a leak.

If a system refuses to hold a vacuum after it has been evacuated, the method of finding the leak will depend on the type of system. A low pressure chiller should be leak checked with controlled hot water where as high pressure systems nitrogen is used.

When a trace gas must be used to locate a leak that can't be found by other means, R-22 is currently the only refrigerant that should be used, as it is less damaging to the atmosphere.

If you suspect a leak or a low charge on a system, bubbles in the liquid line sight glass and/or excessive superheat are the good indicators to help confirm your suspicions. There are other things such as low suction and head pressures or a hissing metering device that also will indicate a low charge. Remember, if a system is low on refrigerant, there must be a leak somewhere in the system. Your problem is to find it, then repair it.

Electronic detectors will find minute leaks to a fraction of a pound per year. However they don't always work well under less than desirable conditions. Using "soap bubbles" though, will pin-point a leak.

The good old days of pressurizing newly installed split systems or built up systems charged with HCFC or CFC refrigerants for leak checking are gone. Today, the law specifies that leak checking will be done using a pressurized inert gas that is environmentally safe such as nitrogen.

The EPA has set some regulations when leaks must be repaired or the owner and possibly the technicians will be held responsible.

For commercial and industrial process refrigeration systems must be repaired when the leak rate exceeds 35% of the system charge per year. For any other appliance containing more than 50 pounds of refrigerant, the leak rate is 15% and must be repaired.

QUESTIONS:

1. Describe what a ternary blend refrigerant is.

2. What is meant by temperature glide?

3. Which of the current refrigerants is it permissible to pressurize the system with nitrogen for leak detection while the system still has the charge?

4. What are the hazards of using the old halide leak detectors?

5. What device is used for finding small leaks?

6. What would be used to pin point a leak?

7. What refrigerant should be used as a tracer refrigerant when leak checking a system that has a leak? Why?

8. How should low pressure centrifugal systems be pressurized?

9. What should be used to pressurize a newly installed split system when looking for leaks?

10. List several things that would indicate that a system had a leak and was low on charge.

REFRIGERANT, OIL AND CONTAMINATION RECOVERY TECHNIQUES

OBJECTIVE 8a

Determine the proper techniques for the recovery of contaminated refrigerants, oils, and refrigeration system components by answering a series of questions.

INTRODUCTION

Most of the old rules for working with refrigerants, oils, and contaminants still stand. Although, because of new EPA laws, new refrigerants and oils, many new rules, and new procedures are becoming a fact of life for the HVAC/R technician.

INFORMATION

Refrigerant Oils

Refrigeration systems that use CFC and HCFC refrigerants were lubricated using oils that were derived from non-paraffin based oils. These oils were mostly made of vegetation products.

Since this field's terms and technology have drastically and quickly changed, it's going to be hard to keep up. However you must if you want to stay in this industry. Hygroscopic, a term that indicates a high affinity to water (the absorption of water) changes the old saying that water and oil don't mix. They do now with the new lubricants now in use!

The two most common new synthetic oils used with the new refrigerants are ester and alkylbenzene based oils. Most refrigeration applications that use HFC-134a, the replacement for R-12 will use ester type oils while the synthetic lubricants based with alkylbenzene will be used with the ternary refrigerants containing HCFCs as part of the refrigerant.

Because ester based oils can not be mixed with any other oils, special procedures will be required when converting existing systems from R-12 to HFC 134a refrigerants. All of the old oil must be removed because 134a will not mix with the old type oils, thus causing lubrication and refrigerant flow problems. Also, because of the new laws, the old methods of flushing out systems after a burn out with liquid refrigerant to clean field tubing is not approved any more and other methods must be used for cleaning. There are now new chemicals now on the market that are safe for this purpose. Some of the new near drop in refrigerants now approved by the EPA over come this problem but not completely in all cases. You must follow the manufacturers instructions when using theses new products.

It is also suggested that after a system has had a burn out, or a leak or a major component failure, an oil sample should be taken to check for contamination.

Refrigerant oils must be handled just as any other potential hazardous material. Used refrigerant oil is not considered contaminated until it is mixed with another oil or contaminant. It must not be mixed with other oils when processed because CFC/HCFC contaminants can be held captive in the oils, and EPA laws must be followed concerning these refrigerants and associated materials. See page 3 Your Responsibilities for additional information concerning this subject.

Recover/Recycle/Reclaim, (The 3 Rs)

It is very clear that the service technician must know the three procedures required to comply within the laws now enforced by the EPA.

Recover - A process of removing refrigerant from any refrigeration/air conditioning system or any other appliance that holds refrigerant, regardless of condition for storage in an approved storage container. No action is taken to clean, dehydrate, or remove acids from the refrigerant.

Recycle - A process to clean refrigerant for reuse by separating the oil from the refrigerant by processing the refrigerant through single or multiple passes. A unit using replaceable filter driers cores that reduce moisture and acids through the absorption processes. The recycle process is designed to clean refrigerants for reuse on site. Recycled refrigerant does not qualify for purity as reclaimed refrigerant.

Reclaim - A process that processes refrigerant to new product specifications that requires chemical analysis. In most cases, it cannot be done on site. Even though reclaimed refrigerant is processed to new-product quality, it must be labeled and color-coded differently than a new or virgin product.

Recovery Techniques

Recovery of refrigerants is the least complicated of the three methods for processing refrigerants. Recovery is generally used to remove refrigerant from an appliance for a short time while performing repairs and then put back in to the system after the system has been leak checked and determined to be leak-proof.

To date, it is not legal to sell or put recovered or recycled refrigerant in another owners appliance. You must check what your unit of assignment regulations are on this law. Your branch of service or command may have special rules on this. Not all of the buildings or equipment on your base or post may be government property.

Recovery is also used to remove refrigerants from an appliance to be stored before being turned into a recycle agency that has been certified to perform reclaim services.

The service technician must never mix different types of refrigerants into the same storage cylinder or single tank because it will be impossible to separate the refrigerants during the reclaim process.

Mixed refrigerants must be stored in a separate tank that is clearly marked. The reprocess center will charge the owner/technician for mixing the refrigerants for the extra cost of disposal or send the refrigerant back for disposal. There are now available to shops an electronic testing device available to identify mixed refrigerants and what those mixtures are. This could be a valuable tool for any shop to have and a money saver. **((Let there be no doubt, if you mix refrigerants you will pay for it. It could become very costly to you, so just don't do it.))**

Some problems one might face during recovery of refrigerants are low ambient temperatures which will slow the recovery process and dehydration time. This problem can be overcome by adding heat to appliance using electric heat lamps, heaters, hot pads or, in some cases, controlled hot water.

Never use an open flame or live steam to heat anything that contains refrigerant or refrigerant oils because of the possibilities of explosions, flame outs, and exposure to the toxic fumes caused by refrigerant that has come in contact with an open flame.

During the recovery process, always use hoses or tubing that are as short as possible and have a diameter as large as possible or at least equal to the pump intake on the recovery unit. This will prevent excessive pressure drops, increased recovery times, increased emission possibilities, and the possibility of the system not being completely evacuated.

Always remember when transferring refrigerant from a recovery unit to a refrigeration appliance, to guard against the trapping of liquid refrigerant between the service valves.

Consumer Complaints

The service technician has to be a diplomat from time to time. Even in the military (Civil Engineering), where customer relations are as important as the service/work itself. We in the military sometimes forget there is more to refrigeration and air conditioning than the job. When consumers complain about additional expenses or time it takes to complete the recovery effort, you, the technician, must take the time to educate them.

- DIPLOMACY IS THE KEY -

Explain that recovery is required to protect human health and the environment and that it is the law.

Explain that you are not the only one doing recovery work, but all professional service technicians are bound to follow the law and to protect the environment.

Above all do not insult your customers by questioning their knowledge of the laws and regulations, but be patient and polite. Your customer will appreciate your explanations and be grateful for your competence. It may even be a good idea to show your certification card to demonstrate that you are a professional doing the job, and doing it right.

Dehydration

After removing the refrigerant from a refrigeration appliance the system must be evacuated or dehydrated even further to remove moisture in the form of water and/or water vapor.

Possibly the worst of all contaminants in refrigeration is moisture. Moisture is a major cause for hermetic type compressor burn out. A hermetic burn out will add even more moisture to a sealed system even if it was dry before hand.

Moisture left inside a system for any time will cause several problems. The most common problems are the formation of hydrochloric and hydrofluoric acids. If these acids are left in a system long enough, copper plating will take place. Actually, evacuation is a good service procedure as one can accomplish two tasks at the same time. (1) Dehydration of the system. (2) Leak testing to determine that the system is leak proof.

There is no such thing as over evacuation, but there are time and conditions, such as a large evacuation system, that during the evacuation process moisture might freeze into ice crystals. This can be overcome several ways. Pressurizing the system with nitrogen and re-evacuating.

You will know that a system has been evacuated properly when the vacuum indicator shows the required finished vacuum and it has held for the proper length of time proving the system is completely dry and no leaks are present. Moisture or a leak in a system will cause the indicator to show a decreased vacuum in a short time.

The amount of time required to achieve proper evacuation levels to dry out a system can vary. Different factors include the capacity of the evacuation unit, ambient temperature, the amount of moisture in the system, the size and volume of the surface area inside the system and the type of refrigerant or system. For example, R-22 will take less time to evacuate than R-12 or R-11 because of the pressures and boiling points.

Remember, when measuring a systems vacuum be sure to isolate the system from the pump. If it is not done, you will find that you may still have a leak, its not in the machine or appliance you were servicing, or its coming back through the pump.

QUESTIONS:

1. What type of refrigerant oil was/is used in CFC/HCFC refrigerant charged systems?

2. What type of bases do the new synthetic oils use?

3. What should be done after a refrigeration system has suffered a major leak or component failure?

4. What are the 3-Rs?

5. What is the major difference between recovered and recycled refrigerants?

6. What is the difference between recycled and reclaimed refrigerant?

7. What is the current law concerning the sale of recovered or recycled refrigerants?

8. How would you speed up the process of removing refrigerant from a low pressure refrigeration system?

9. How are pressure drop problems eliminated during the recovery or recycling process on large systems?

10. How would you prevent moisture from freezing during the evacuation process of a refrigeration system?

SAFETY

OBJECTIVE 9a

Identify the proper safety procedures when working with CFC and HCFC refrigerants and refrigeration systems by answering a series of questions.

INTRODUCTION

It should not surprise anyone that safety is an important part of the EPA Certification Program. More than likely, the first thing you heard when you arrived for your basic training in the military had to deal with safety. The Technical Instructor with stripes down to his wrist jumps on the bus forcefully stressing important items like safety. "Watch your step; Don't fall off the bus; Don't trip over the bags", and ever since then, they have been talking safety, safety, and more safety. The EPA is no different and you can be sure it will be an important part of the certification test.

INFORMATION

General Safety

EPA safety is not much different in most areas than what you are already aware of, and hopefully practicing. For example, you should always use personal protective equipment such as safety glasses (goggles), safety shoes, and when required, a back support when working with refrigerants.

Most military and government employees are issued safety items and are responsible for them. In some cases, certain work areas will have special equipment located in the individual mechanical rooms to cover the special safety requirements for that mechanical room. The EPA and the military expect you to use proper safety equipment and to follow proper safety procedures, you can even be prosecuted in some cases for not following established safety regulations.

Solvent and Chemical Safety

When working with any refrigerant solvents or any chemicals, never trust your memory as to what special precautions are required. Always review material safety data sheets. These material safety data sheets are supplied by the manufacturers, the EPA, and military safety regulations. Also, don't forget to protect yourself by wearing the proper protective clothing and butyl lined gloves when handling chemicals.

Nitrogen Safety

As you have been reading and studying this material, you have seen a lot about using nitrogen for pressurizing different types of appliances. Note that it has never been suggested to use oxygen or air for pressurizing a system. This is for good reason. Oxygen, or compressed air mixed with refrigerant oil under pressure can explode.

Nitrogen is the inert gas that is certified safe for pressurizing, dehydration, and purging procedures for any refrigeration system. But there are safety precautions that must be followed. Nitrogen cylinders are under very high pressures, pressures as high as 3,000 PSI. 3,000 PSI is enough to blow apart any hermetic compressor or other system component turning them into bombs of exploding shrapnel. Most refrigeration appliances will only have a certified burst pressure of 500 PSIG, 3,000 PSIG far exceeds this pressure.

When using nitrogen, a pressure regulator must be installed on the nitrogen storage cylinder that will drop the pressure, leaving the cylinder to safe working pressures designed for the procedures you are performing. These pressures can range from 1 to 5 PSI for purging and dehydration to as high as the design high side test pressure on the equipment name plate for leak testing or blowing debris from a newly installed system.

There should also be a pressure relief valve down stream from the pressure regulator as a precaution in case the pressure regulator becomes defective and over feeds gas beyond its pressure setting.

Common sense tells you never to install pressure regulators in series with each other to increase the volume. If you require to have an increased volume of nitrogen to complete your work, always install the pressure regulators parallel to each other.

If a valve has developed corrosion, replace it and do not attempt to take it apart and clean it. This would invalidate the certification that all pressure valves must have by law. This would also expose the mechanic to dangers that a defective valve could cause.

Refrigerant Safety

Refrigerants are generally considered to be safe to work around, but there are safety rules that must be followed. All refrigerants are heavier than air and in large quantities in a closed space, such as a mechanical room, oxygen can be forced out of the room or above ones head. If this were to happen and technicians are in the area, asphyxia can/will follow, so vacate and ventilate the area.

The law today requires mechanical rooms to have special sensors, alarms, and ventilation systems to prevent asphyxiation problems for the worker.

As with a case for this author, even that was not enough. The chiller bay that I was working on had four centrifugal air conditioners in it. We had all the alarms, ventilators, sensors, and even an air tank breathing apparatus as required for system with large charges of CFCs/HCFCs such as R-11, R113, R-12 or R-22. The breathing apparatus failed and the only thing that saved me was the buddy system, a rule that we had in the shop. My co-worker dragged me to safety.

The point is, if you know of a possible danger, use all the safety measures required to make the work place safe, even exceed them if required.

Always ventilate an area suspected to be full of refrigerant before entering it. Breathing or inhaling refrigerant vapors or mist in high concentrations can cause all kinds of problems. Such things as heart irregularities unconsciousness, and even death. Over a long period of time, brain damage and lung disorders can also be traced back to prolonged exposure to refrigerant vapors or mist. That is why a self contained breathing apparatus (SCBA) will be used.

Oxygen deprivation (asphyxia) is the most common cause of death that occurs with refrigerant accidents. But as you can see common sense and a little pre-planning can eliminate this sad statistic.

Believe it or not, scraping ice off of a sight glass or viewing glass with a screw driver, file, or knife blade is a prime example of not using common sense. The effect of breaking a sight or viewing glass on a system under pressure in close proximity can be devastating. If ice were to block your vision, use an alcohol spray which to melt it away, the same way as de-icer used on a car window in the winter.

Refrigerants all are assigned a safety classification. A refrigerant classified A-1 is the most safe according to ASHRAE. But no matter what the classification, the common rules bare repeating.

1. Never apply an open flame or live steam to a refrigerant cylinder or vessel. An open flame will change certain refrigerants to phosgene gas.

2. Do not cut, solder, or weld any refrigerant line or system when there is refrigerant in the unit.

3. Do not use oxygen or air to pressurize or purge a refrigeration system. The refrigeration oil can mix with oxygen and create an explosive situation.

4. Check the quality of the air in a mechanical room before entering.

5. When using nitrogen always use a regulator, relief valves, and never exceed system design pressures.

6. Do not try to repair or adjust pressure safety devices that are factory set and certified.

7. Always follow safety directives when working with chemicals or special equipment.

8. Before operating compressor be sure all valves are adjusted to the proper position, especially the discharge service valve. If left closed, the compressor could blow up or damage the compressor valves, rods, or pistons.

ASHRAE Standard 15, requires that all mechanical rooms have a sensor and an alarm system where systems are charged with A-1 type refrigerants which includes R-12, R134a, R-11 as well as others, checking for oxygen deprivation.

For safety reasons, all refrigeration systems are required to have some pressure relief device for protection. Some systems have huge amounts of refrigerants in them enough to force all the oxygen out of the mechanical room.

Cylinder Safety

You should already be aware of safety regulations concerning the proper procedures for handling refrigerant and other pressurized cylinders associated with the HVAC/R field.

There are now a few new rules that have been added by the EPA and we will review some of the these safety regulations.

In the past few years, the industry has gone to what is called disposable (throw-away) cylinders. These cylinders come in several sizes generally 1, 15, 25, 30 and 50 pound sizes. They are constructed of steel, but are very thin skinned, and are not designed for prolonged storage or reuse. It is against all civil and military laws to reuse these cylinders for any other purpose than to supply new or virgin refrigerant. They must never be used for recovery, recycling, storage, or for conversion to other uses such as air tanks.

Once the refrigerant has been used or extracted, the cylinder must be disposed of by rendering it useless. The pressure reduced to 0 PSI, the valve stem broken off, holes drilled into it or cut in half and then sent to the scrap yard or DRMO to be recycled.

One should not confuse bulk storage cylinders with disposable cylinders. The military/government agencies will use these type of cylinders quite often because of costs. These cylinders are generally painted orange with the type of refrigerant stenciled on the side. This alerts the civilian suppliers that these cylinders are government property.

All refrigerants are color-coded even the cylinders owned by the US government with their orange cylinders. The color orange denotes refrigerant. Commercial cylinders, regardless whether they are disposable or bulk storage, are color-coded and those colors are universal.

These cylinders must never be used to recover, reclaim, or recycle refrigerants. They are to be used for shipping and storage of new or virgin refrigerants only.

All refrigerant cylinders should not be damaged and must be rust free, stored, and shipped only in an upright position and secured in such a way that will not be tipped over. Whenever possible, they should be stored in an area where they are out of direct sunlight and separated by the type of gas that they hold.

Reclaim, Recycle, and Recovery Cylinder Safety

Refillable or recovery cylinders or vessels are the only cylinders that should be used for recovery, recycling, reclaiming, and shipping of used refrigerants. These cylinders must be color-coded as specified by the EPA with yellow tops and gray bodies. Reusable cylinders, include recovery high pressure cylinders, are required to be hydrostatically tested and certified safe with a date stamp every 5 years. If the cylinder is to be used for shipping, it must be designated by DOT as refillable to meet all safety requirements.

When refilling a refillable cylinder, it must never be filled more than 80% of its capacity by weight, because cylinder pressure may rise in heated areas and could cause an explosion or the safety plug to release the charge.

When transferring refrigerant to a pressurized refillable cylinder, the device used should have some type of control such as a mechanical float, electronic shut off, or a weight control to stop the filling process automatically. If one of these devices is not available, a scales must be used and control done manually. Cylinders must never be filled above the 80% weight limit of the vessel. Its the law.

Under no circumstances should heat such as an open flame or live steam be used to speed up the transfer process of refrigerant from one vessel to another. The chance of an explosion and serious injury to people could result. One of those people could be you!

QUESTIONS:

1. What personal safety items should you have with you when working with refrigerants and chemicals?

2. When working with chemicals, what materials should you review before starting to work?

3. When is it permissible to use compressed air or oxygen for pressurizing a refrigeration system?

4. What should you do if a customer complains about the time and expense it takes to recover refrigerants?

5. What two devices would be used whenever pressurizing a refrigeration system with nitrogen?

6. How should pressure regulators be installed when more than one is required?

7. How would high quantities of refrigerant that leaked into a closed space cause asphyxia?

8. What directive describes the safety devices required in a room that contains refrigeration systems that have A-1 type refrigerant charges?

9. What are the rules for disposing of used refrigerant cylinders or vessels?

10. What is the maximum that a recovery refrigerant cylinder should be refilled under normal conditions?

SHIPPING AND DISPOSAL PROCEDURES

OBJECTIVE 10a

Identify the approved EPA procedures for shipping and disposal of contaminated refrigerants, oils, refrigeration systems, and refrigeration system components by answering a series of questions.

INTRODUCTION

The EPA has required that the industry follow a few new rules to ensure that contaminants do not get into the environment. The rules are not much more than what we already do in transporting and the disposal of refrigeration products.

INFORMATION

Shipping

The military has already moved in the direction of EPA regulations for the shipping and disposal of used refrigerants and refrigeration/air conditioning units and contaminated components.

Your unit has an office that has the latest up-to-date information that you are required to follow. See page 3 Your Responsibilities for additional information.

Everyone must be aware of certain EPA and DOT Regulations. The DOT 49 CFI lists the requirements for hazardous 2.2 non-flammable compressed gases when shipping used refrigerants. All cylinders will be required to have a DOT classification tag or label attached to the bottle or cylinder. Another important requirements is the shipping papers will list the total weight of refrigerant and the number of cylinders for each type of gas being shipped.

When shipping or transporting the refrigerant cylinders, they must be stored vertically secured to prevent rolling or shifting. This does not just mean transporting to the reclaim center or pick up point, but also transporting anywhere to include, to and from the work site.

Disposal

Before anyone services, opens, or disposes of any refrigeration appliances, that person must have a valid EPA Certification for the type of appliance for which their certificate is approved. Before any work can proceed, those people must have been certified and approved to meet EPA laws and regulations.

Alone, refrigerant oils are not considered contaminated unless mixed with other oils. Most reclaim units will remove refrigerant from the oil by heating and boiling it out while the compressor pumps it into the refillable storage tank.

Oils that contain acids must be processed separately. Refrigerant oil should never be used as heating oil unless it has been processed and certified as refrigerant free.

Disposal of HVAC/R Equipment

When turning in scrap refrigeration equipment and system components, the oil and refrigerant must be removed. The salvage or recycle center is responsible to certify that this has been done.

In the military, your shop will likely have this responsibility and will have to certify that the EPA requirements have been met before turning scrap into DRMO or salvage.

QUESTIONS:

1. What is the regulation that must be followed when shipping hazardous non-flammable compressed gasses?

2. What type of tag will be required when shipping used refrigerant filled cylinders?

3. How should refrigerant cylinders be shipped?

4. When are refrigerant oils considered contaminated?

5. Who is the responsible agent to insure that scrapped refrigeration equipment meets EPA standards when it is to be recycled or scrapped.

Certification Test Requirements

You have completed the study material that you will be required to know to satisfy the EPA requirements for the Universal Technician Certificate.

Go back and review/study your notes and then go back and review the book from cover to cover. Study the terms, the charts, the important dates, the orientation part of the book, and the questions at the end of each unit. Next, take the pretest in the Appendix of this study guide to determine if you have prepared yourself enough to take the computer-based test.

The pretest is designed to let you know how the EPA has formatted and has written the certification tests so you will know what to expect. If you find that there are areas you need more study while taking the pretest you will see a page number in the area around the question go back to that area and study it to find the correct answer.

When you take the certification test you will be taking 4 separate tests. The first test you must take for any type of certification will be the Core Test (this is an EPA requirement) followed by the Type I, Type II, and Type III. The pretest is set up the same way as the test you will be taking for certification Each of you will be taking a different version of the certification test as there are no two tests exactly the same. There will be a total of 100 questions if you are going for Universal Certification. You will be required to take 25 core questions no matter what type of certification you are testing for, then there will be 25 questions for each of the certification(s) that you require. You must attain at least a 70% (72%) on each of the tests to achieve certification.

Your AFSC /MOS/Specialty may or may not require for you to take all four tests, but you must study for all parts of the pretest and the book because the way that the certification tests are written. There are areas in each type of certification that are common to all types of systems. Some of the common areas will include safety, dehydration, leaks, purging to name a few.

While taking the certification tests you will find when you complete each test the computer will give you a test summary. Keep a list of the letter codes in the areas that you find you are weak in so you can go back and restudy those areas identified by subjects on page ix of this book Remedial Study References for Certification Testing.

PRETEST SAMPLE QUESTIONS

FOR DOD EPA UNIVERSAL TECHNICIAN CERTIFICATION

INSTRUCTIONS

The following pages contain sample questions for each of the four areas required for Universal Technician certification. These questions do not quote the actual test. This sample test is only designed to give you an idea of what to expect and also will give you an idea of how well prepared you are for "THE TEST". Each question is referenced with a page number.

There will be 25 question covering each of the 4 parts of the test. To pass this test you will be required to correctly answer 18 of the 25 questions in each of the 4 tests.

This test is made up of 4 parts. To pass it satisfactorily you must receive not less than a 72% passing score on each test.

Read each question very carefully. Be sure to read each and all of the responses. Some of the responses will have several answers that are correct. You must select the answer that is the best or the most correct.

Once you have completed the test you may have your supervisor/instructor grade the test, he will advise you how you did and what additional study you may require.

SAMPLE CERTIFICATION TEST
CORE QUESTIONS

THE NUMBER(s) AFTER THE # IS THE REFERENCE PAGE NUMBER

For questions 1 thru 4 match the dates listed below to the event listed below the answers

ANSWERS

a. The 1930s b. 15 November l990

c. 14 November 1994 d. 1 July l992

THE EVENT

1. The Clean Air Act #ii, vii, 19, 21 (a) (b) (c) (d)

2. The Technician Certification dead line #vii, 25 (a) (b) (c) (d)

3. Venting of CFC/HCFC refrigerants law took effect #vii (a) (b) (c) (d)

4. Study of the ozone began #13 (a) (b) (c) (d)

5. You are stationed at Herby C Husker Air Station located in the state of Nebraska. You know that Nebraska has a state law that states "Bulk refrigerants shipped on any public transportation must be shipped inside an air tight shipping container able to withstand 5,000 pounds of crush pressure". Which laws or regulations must you follow when shipping used refrigerant to Denver Colorado for processing? Note: Colorado State laws is the same as the EPA laws. #19

   a. EPA, DOD and USAF regulations

   b. Nebraska state laws

   c. DOT regulations

   d. All of the above

6. Which of the following is the most destructive to the ozone protective layer? #15, 16

   a. Water soluble chlorine

   b. Nonwater soluble chlorine

   c. HCFCs such as R-22

   d. Evaporated sea water

7. Which of the following is an agreement that states that the United States will not import CFC type refrigerants after 1995? #iv, vii, 21

   a. The Clean Air Act

   b. The Montreal Protocol

   c. The Emissions Control Act

   d. The Environmental Protection Agency Agreement

8. What type of technician certificate(s) is/are required to service all types of refrigeration and air conditioning systems/appliances after 14 November 1994? #3, 4, 25, 35, 41, 69

   a. Type I and II

   b. Type I and III

   c. Universal

   d. Type III only because it includes Type I and Type II

9. As of 12 August l993 all types of recovery equipment must be registered with which of the following office(s) or department? #vii, 2, 4

   a. Headquarters EPA Washington DC

   b. Your EPA regional office

   c. Your state EPA office

   d. All of the above

10. Which of the following refrigerants does the least harm to the ozone? #v, 14, 15, 17

    a. R-123 b. R134a

    c. R22 d. R12

11. Which of the following refrigerants is the most harmful to the ozone? #v, 14, 15

    a. HCFCs b. HFCs

    c. CFCs d. HSFCs

12. Which of the following is a low pressure refrigerant? #iv, viii, 21, 43

    a. R-11 b. R-113

    c. R-123 d. All are low pressure refrigerants

13. How many atoms will one molecule of ozone contain? #14, 16

    a. 1 b. 2

    c. 3 d. 5

14. Refrigeration systems/appliances that use R-11, R-113 and R-123 would be classified as what type of system and will require what type of certification for servicing? #iii, viii, 41

	TYPE OF SYSTEM	TYPE OF CERTIFICATION
a.	High pressure	Type II
b.	Low pressure	Type I
c.	High pressure	Universal
d.	Low pressure	Type III

15. Which of the following types of systems fall under the EPA definition for "Industrial Process Refrigeration"?#iii, 41, 44

    a. Industrial ice machines and ice rinks

    b. Industrial indirect expansion liquid AC chillers

    c. Industrial food processing/storage plants

    d. Any refrigeration/air conditioning system used in the process of manufacturing in any way

16. The loss of a small amount of refrigerant while removing service hoses is _______________. #ii

    a. A deminimus release of refrigerant

    b. Against all EPA laws

    c. Permitted until 14 November l994

    d. Both a and c are correct

For questions 16 through 22 match the EPA terms to the definitions.

EPA TERMS

a. Reclaim	b. Recover
c. Recycle	d. Small appliance

DEFINITIONS

17. A manufactured hermetically sealed unit containing 5 pounds or less refrigerant charge. #vi (a) (b) (c) (d)

18. A refrigerant that has been cleaned and the oil separated. #v, 56 (a) (b) (c) (d)

19. A refrigerant that has been reprocessed to ARI standards. #v, 56 (a) (b) (c) (d)

20. A refrigerant that has been removed from a system but not processed in any way. #v, 56 (a) (b) (c) (d)

21. A type of system that requires a process tube or stub. #v, vi, 25, 56 (a) (b) (c) (d)

22. Requires a Type I Technicians certificate to service. # 2, 25 (a) (b) (c) (d)

23. The EPA definition for "OPENING", would apply to include all the service procedures listed EXCEPT which one of the following? #iv

    a. The opening of a pressurized appliance

    b. The opening of an appliance that has lost its charge

    c. The opening of an appliance that has been pumped down to 1 to 5 PSIG

    d. The opening of any appliance to include opening a service valve or process tube

24. Once recycle/recovery units have met EPA requirements it must be retested or inspected how often? #20

    a. Yearly

    b. Every 2 years

    c. Every 3 years

    d. Every 5 years

25. Which of the following types of refrigeration appliances would it be permissible to use a passive recovery device for evacuation? #25

  a. A centrifugal liquid chiller air conditioner

  b. A reciprocating liquid chiller air conditioner

  c. A commercial walk-in refrigeration system

  d. A domestic refrigerator or window AC unit

SAMPLE CERTIFICATION TEST QUESTIONS TYPE I

1. R-134a is a drop in refrigerant for which of the following refrigerants? #15, 51

   a. R-12 b. R-22

   c. R-502 d. None

2. What is the maximum amount of refrigerant charge that Type I appliances will hold? #vi, 25

   a. 3 pounds b. 5 pounds

   c. 10 pounds d. 15 pounds

3. Which of the following appliances would not fall under Type I appliances? #2, 25, 35

   a. A MVAC like conditioner that holds 3 pounds of R-12

   b. A water cooler that holds 13 ounces of R-12

   c. A food freezer that holds 22 ounces of R-22

   d. An ice maker charged with 12 ounces of R-12

4. Which of the following statements is true concerning purging a controlled refrigerant? #27

   a. Purging a small amount of refrigerant while filling the unit qualifies as a de minimus purge

   b. Purging refrigerant to add oil to a system is a now lawful

   c. Charging station have been out-lawed since 15 July l992 because purging is required to fill them

   d. All purged refrigerant must be captured and recovered

5. All recycled R-12 cylinders for servicing Type I appliances must be color coded ___________. #64

   a. Light blue b. Dark green

   c Light green d. None of the above

6. What type of service aperture will Type I appliances have when they leave the factory? #v, 25

   a. None

   b. A process stub

   c. A 3 way service valve

   d. A schrader line tap valve

ARI Standard 740-93 has set the date of 15 November l993 imposing more stringent requirements for recovery type equipment used with TYPE I appliances. Answer questions 7 and 8 stating the before and after l5 November l993 standards stated.

BEFORE / AFTER
Remove % Charge/Pull " vacuum / Remove % Charge/Pull " Vacuum

7. For a system with a non-functioning compressor #vii, 26

   a. 80% charge 4" vac. / 80% charge 4" vac

   b. 80% charge 4" vac. / 80% charge 10" vac.

   c. 80% charge 4" vac. / 90% charge 4" vac.

   d. 80% charge 4" vac. / 100% charge 29" vac.

8. For a system with an operational compressor

   a. 80% charge 4" vac. / 80% charge 4 " vac. #vii, 26

   b. 80% charge 4" vac / 80% charge 10" vac.

   c. 80% charge 4" vac. / 90% charge 4" vac.

   d. 80% charge 4" vac. / 100% charge 29" vac.

9. Which of the following statements is true concerning recovery type equipment used for Type I appliances? #vii, 2, 28

    a. Home made recovery/recycle units have been authorized by the EPA

    b. All recovery type equipment should have been registered with the EPA by 12 August l993

    c. Passive recovery is the most common method for refrigerant recovery used for Type I appliances

    d. Answers a. b. and c. are all true statements

10. What is the primary difference between a passive recovery unit and an active recovery unit? #27

    a. Passive units use the appliance compressor to pump refrigerant from the appliance, active units don't

    b. Passive units do not use the appliance compressor to pump the refrigerant from the appliance, units do

    c. Passive units are not required to be registered with the EPA, active units are

    d. Active units are not required to be registered with the EPA, passive units are

11. All types of recovery/recycling units manufactured after 15 November l993 will be required to have which of the following? #vii, 26

    a. A calibration stamp or label

    b. An EPA approved type of certification label

    c. Flexible lines that meet the new EPA specification

    d. Manual triple shut-offs and triple seal isolation valves

12. Which of the following would be acceptable for finding a leak in an appliance that had lost its charge? #19, 28, 52

    a. Pressurizing the system with dry nitrogen and using soap bubbles to locate the leak

    b. Add some R-22 then pressurizing the system with dry nitrogen and the testing for leaks using a standard type leak detector

    c. Pressurizing the system with compressed air and using soap bubbles to locate the leak

    d. Answers a. and b. are permissible; c. is dangerous and should never be done

13. If you know that a domestic refrigerator has a leak in it somewhere, the current law stipulates which of the following? #26

    a. It does not have to be repaired

    b. It must be repaired with out delay

    c. It must be repaired or evacuated and scrapped (salvaged)

    d. It must be repaired only if the charge is R-12 a CFC type refrigerant

14. When scrapping a Type I system appliance, who is responsible to insure that the refrigerant charge has been removed and disposed of, in accordance with EPA laws? #67, 68

    a. The owner

    b. The dealer

    c. The scrap dealer

    d. The certified service technician

15. R-12 refrigerant will no longer be manufactured for Type I appliances after ________. #vii, 20, 21

    a. Year l990

    b. Year 1995

    c. Year 2000

    d. Year 2020

16. Which of the following refrigerants will not damage the ozone protective layer? #v, 15

    a. HCHCs and HCFCs

    b. HCFCs and CFCs

    c. HCFCs and HFCs

    d. HFC only

17. What will happen should CFCs or HCFCs refrigerants come in contact with an open flame? #52, 57

    a. Chlorine gas will be generated

    b. An explosion will take place

    c. Hydrogen gas will be generated

    d. Hydrochloric/Hydrofluoric acid will form

18. When you see a refrigerant cylinder that has a gray body and a yellow top what should this indicate to you? #64

    a. The cylinder contains mixed refrigerants

    b. The cylinder is designed to hold an inert gas

    c. The cylinder is designed to hold the new refrigerant HFC 123

    d. The cylinder is designed to hold, store or ship recovered refrigerant

19. Why would you strike a compressor with several sharp blows while pulling a vacuum on an appliance? #29

    a. To burp it, causing refrigerant to escape from the oil and compressor

    b. To break the electrical field

    c. To loosen the connections

    d. To break the vacuum

20. What type of certification test/tests will you be required to pass in order to be certified after 14 November l994, to service any small appliance? #2, 25

    a. Type I only

    b. Type I plus Core

    c. Type I and Type II

    d. Type I plus Core or Universal

21. Which of the following would be an indication that the compressor motor in a small appliance has burnt up? #28

    a. The paint has pealed off of the compressor

    b. The compressor is hot to the touch

    c. The refrigerant has a pungent odor

    d. The compressor won't run

22. Where will saturated refrigerant be located in a refrigeration system while it is operating? #29

    a. In the evaporator and the condenser

    b. In the suction and discharge lines

    c. In the evaporator only

    d. In the liquid line only

23. What part of the refrigeration system will contain superheated vapor while the system is operating? #29

    a. The compressor

    b. The condenser and evaporator

    c. The suction/discharge lines and compressor

    d. All of the above

24. When is the only time it is permitted to purge the contents of an appliance to the atmosphere with out breaking the law? #28

    a. Never - it must never be done without exception.

    b. Only if the lines in the system are blocked and refrigerant cannot be evacuated.

    c. Only after the refrigerant has been removed and you are trying to blow out the system with nitrogen.

    d. Only in emergencies that could cause a life threatening hazard and special approval has been given by the state EPA office.

25. While operating a recovery type device, which of the following would cause excessively high cylinder pressures? #28

    a. Oversized service hoses

    b. An oversized recovery system

    c. Air in the storage or recovery vessel

    d. All of the above would cause the same effect

SAMPLE CERTIFICATION TEST QUESTIONS TYPE II

1. The primary difference between Type I and Type II refrigeration appliances is____________. #35

    a. The refrigeration systems will have open type compressors only.

    b. The refrigerant charge will be greater that five pounds.

    c. The systems will always be remote or split systems.

    d. System II systems will not have HFC type refrigerant charges.

2. Which of the following type(s) of equipment will a technician **NOT** be able to service if he/she possesses only a Type II Technician certificate? #iv, 2, 35

    a. High pressure and very high pressure systems

    b. Self contained package type DX air conditioners

    c. Reciprocating liquid chillers with less than 200 pounds of refrigerant charge

    d. Automobile comfort cooling type air conditioning systems charged with CFC R-12 refrigerant only

3. How often should recovery equipment be leak checked? #36

    a. Each time it is used

    b. Everyday or everyday it is used

    c. At least once a week even if it is not used

    d. Monthly and the log must be signed an certified that it was done

4. Recovery type equipment today must be able to be used with different types of refrigerants. What must be done when converting from R-502 to R-22? #36

    a. Today's equipment requires no special servicing

    b. The Oil and refrigerant filters must be replaced

    c. Only the oil filters must be changed

    d. Only the oil must be changed

5. On 15 November l993, the standard was changed for any recovery type equipment that was built after that date. What is the current standard for the amount of vacuum that recovery type equipment must pull on appliances charged with R-22 with less than 200 pounds total charge? #vii, 36

   a. 0" Hg

   b. 10" Hg

   c. 18" Hg

   d. 28.9" Hg

6. The standard of 15 November 1993 also affected systems over 200 pounds charged with refrigerants OTHER THAN R - 22. What is standard for these systems today? #viii, 36

   a. The same as systems under 200 pounds

   b. 10" Hg

   c. 15" Hg

   d. 25 mm Absolute

7. When could the requirement be waived for pulling a vacuum on a Type II system while repairing it? #37

   a. If pulling a vacuum would cause refrigerant to be contaminated with air.

   b. If pulling a vacuum would require over filling the recovery vessel.

   c. If pulling a vacuum would cause over heating of the recovery unit causing it to burn up.

   d. EPA law does not provide for any waivers for any reason for not pulling the required standard vacuum.

8. Refrigerant recovery on large Type II appliances is done in several stages to increase the speed of the process. What is the recommended first stage to speed up refrigerant removal from the system? #38

   a. Cool the appliance with ice packs

   b. Remove refrigerant in a liquid state first

   c. Operate the appliance compressor to speed up the process

   d. Heat the appliance with heat lamps to build up system pressures to speed up evacuation process

9. Where should the recovery hoses be connected to a large Type II system to remove liquid refrigerant? #38

   a. From the lowest point in the system where liquid refrigerant will settle

   b. From the King valve on the receiver

   c. From the bottom of the condenser

   d. From both service valves

10. Which of the Type II appliances are not effected by the 15 November l993 recovery standards which established more stringent recovery requirements? #viii, 25, 35

   a. All Type II appliances have the same standard NO EXCEPTIONS

   b. MVAC like appliances

   c. Small appliances with less than 5 pounds charge

   d. Industrial manufacturing refrigeration systems

11. What advantage do open drive recovery systems have over hermetic type recovery systems? #30, 37

   a. None, actually the hermetics operate at higher RPMs and are capable of achieving deeper vacuums in a shorter time

   b. Open type reclaimers have a larger displacement capability and are able to pull lower vacuums

   c. Open driver compressors are not subject to burn out while removing low volumes of refrigerants

   d. Open drive compressors will permit motor slippage unlike hermetic units which have a tendency to lock/burn up

12 What advantage do recycle units have over recovery units? #v, 21, 56

   a. Recycle units are able to pull deeper vacuums

   b. Recycle units are capable of removing acids

   c. Recycle units are capable of removing noncondensables from the refrigerant

   d. Recycle units will have safety controls not found on regular recovery units, and most recovery units can only be used with a single refrigerant

13. While servicing a large commercial refrigeration system which of the following would lead you to suspect that the system was low on refrigerant charge? #52

    a. Bubbles in the sight glass

    b. Frost on the suction line and accumulator

    c. A compressor head that is cold to the touch

    d. Normal to high head pressure, suction pressure that suddenly rises and falls

14. Which of the following devices would be used to pin point a small leak? #52

    a. A halide detector

    b. An electronic leak detector

    c. The use of a special soap bubble solution

    d. Evacuation equipment to measure pressure rise in the system to determine volume of the leak

15. Current regulations require that if a leak exceeds 35% of the systems total charge in one year it must be repaired. Which of the following types of equipment does this 35% leak rate pertain to? #44, 52

    a. Commercial/industrial process refrigeration

    b. Large package type air conditioning systems

    c. Small reciprocating liquid chillers

    d. All Type II type systems

16. What is the advantage of recovering refrigerant from a Type II system as a vapor rather that a liquid? #38

    a. It is much quicker

    b. It reduces oil loss

    c. It is much easier

    d. All of the above

17. What will high performance recovery type units use to speed up the process of recovery or recycling of refrigerants? #37, 45

    a. Water cooled condensers that use common tap water

    b. Special subcoolers that flash off refrigerant to keep head pressures low

    c. Special intercoolers that pass cool incoming vapors to come in contact with the superheated discharge gasses before they pass on to the storage cylinders or vessels

    d. None of the above

18. To replace an evaporator on a large R-22 system that contains 35 pounds of refrigerant charge which of the following procedures is the most correct procedure to follow? #37, 38

    a. Recover the whole system charge and pull a vacuum of at least 4" Hg

    b. Pump the system down to 1 to 5 pounds of pressure and isolate the component from the rest of the system before removing it

    c. Pump the system down to 4" Hg and isolate the evaporator from the rest of system then, pressurize the system to atmospheric pressure with dry nitrogen before opening it up for replacement

    d. Pump the system down to 10 " Hg, isolate and watch to see if the pressure rises, if it does the entire charge must be recovered prior to opening the system to remove the evaporator

19. Why should a newly installed split air conditioner system be pressurized with dry nitrogen before charging it with refrigerant? #28, 34, 62

    a. To leak check the system

    b. To purge loose particles from the lines

    c. To dehydrate the system of moisture vapor

    d. a, b, and c are all reasons for pressurizing a newly installed system with dry nitrogen

20. Traces of oil on any of the component parts of a refrigeration system would indicate which of the following. #52

   a. The system requires a good cleaning

   b. The system more than likely has a leak

   c. The machine is new and still has an oil preservative on it

   d. Traces of oil means nothing, it is not uncommon for older systems to be covered with oil because of the environment in most mechanical rooms

21. What is the most common type of refrigerant would you expect to find in a 5 Ton PTAC unit? #30

   a. R-123 b. R-22

   c. R-134a d R-502

22. Which of the following refrigerants would you as a service technician encounter temperature glide? #51

   a. R-12 (CFC refrigerant

   b. R-22 (HCFC refrigerant)

   c. R-502 (binary or azeotropic refrigerant)

   d. MP-39 (blended or ternary refrigerant)

23. Which of the following statements are true concerning recovery/recycle equipment? #36

   a. Recovery equipment used with HFC refrigerant must not be used with other refrigerants

   b. Recovery equipment used with CFC refrigerants must not be used with HCFC refrigerant

   c. Recovery equipment must be overhauled and recertified every 5 years after its purchase date

   d. None of the above statements are true

24. What color are United States Government owned bulk storage cylinders used for shipping new or virgin refrigerants? #64

    a. Red, white and blue

    b. Olive drab green

    c. Orange

    d. The same color as all other refrigerant cylinders

25. As you already know when filling a recovery or storage cylinder or vessel it should never be filled over 80% full under normal conditions. Which of the following methods listed is **NOT** a proper method to determine that a cylinder is over filled during a recovery process? #65

    a. Using an automatic electronic flow control that measures refrigerant weight.

    b. Using an automatic liquid level sensor or float device.

    c. Using a scales to manually measure the cylinder weight during the filling process.

    d. Using a wrench to tap the side of the cylinder to detect the liquid level as you fill the cylinder, stopping the filling process when the sound change is 6" below the shoulder of the cylinder or vessel.

SAMPLE CERTIFICATION TEST QUESTIONS TYPE III

1. Which of the following statements are true concerning Type III Systems. #3, 41

    a. Type III systems include industrial process systems

    b. Type III systems are classified as low pressure systems

    c. Answers a and b are correct

    d. Answer b is the only correct answer

2. What is the major service problem associated with low pressure centrifugal systems? #41, 42

    a. Air and moisture leaking into the systems

    b. Refrigerant leaking out of the systems

    c. Rupturing of the diaphragm burst disk

    d. Oil contamination

3. What will the High Pressure Safety Control be set for on a centrifugal air conditioner system? #41

    a. 4 to 6 PSI

    b. 8 to 10 PSI

    c. 10 to 15 PSI

    d. 150 to 180 PSI

4. Where would the lowest point be in a centrifugal air conditioner appliance that refrigerant could settle? #42

    a. The evaporator charging valve

    b. The condenser service valve

    c. The compressor cooler jacket

    d. The purge unit exhaust port

5. What is the designed burst pressure for a rupture disk on a centrifugal air conditioner system? #42, 43, 44, 45

   a. 5 PSI   b. 10 PSI

   c. 15 PSI   d. 20 PSI

6. Where is the rupture disk located on a centrifugal air conditioner appliance? #42

   a. At the highest point in the system

   b. At the lowest point in the system

   c. The upper part of the evaporator

   d. The lower part of the condenser

7. The factory installed purge unit found on centrifugal air conditioning systems is designed to remove noncondensables such a air and nitrogen from the system. Where does the recovered refrigerant go after it leaves the purge unit? #42

   a. The evaporator

   b. The condenser

   c. The compressor intercooler

   d. The recovery service vessel

8. What purpose does a hydrostatic tube tester serve? #44

   a. To test for water flow through the tube bundles of a centrifugal air conditioner

   b. To test the quality of the water that flows through tube bundles of a centrifugal air conditioner

   c. To test for leaks

   d. There is no such item

9. Why would a service technician run controlled hot water through a centrifugal systems tubing bundles? #44

    a. To carefully raise the systems refrigerant pressures to perform a leak test

    b. To wash or flush out oil or scale build up inside the tubing bundles

    c. To carefully raise system pressures to test the high pressure safety motor control

    d. To carefully raise the system temperatures to test the high temperature cut out control

10. EPA regulations require that when a leak exceeds 35% of the systems charge on industrial processing equipment in one year, it must be repaired. What is the requirement for low pressure appliances charged with more than 50 pounds of refrigerant? #44

    a. 15% b. 20%

    c. 25% d. 30%

11. Recovery/recycle equipment used on low pressure appliances are required to have a rupture disk set to burst at 15 PSI. What should the high pressure cut out be set for on these appliances? #43

    a. 5 PSI b. 10 PSI

    c. 12.5 PSI d. 5 PSI

12. What is done to prevent water in the tubing bundles from freezing when recovering refrigerant from a centrifugal air conditioner? #45

    a. Run the systems water pumps

    b. Run the system impellers

    c. Wrap the system with heating blankets

    d. Do not recover refrigerant in a liquid state

13. Why is it a good idea to recharge refrigerant into a centrifugal refrigeration system as a vapor rather than as a liquid when the charging process is begun? #46

    a. It isn't, it will take three times longer to charge the system

    b. It will prevent liquid hammer on the tubing bundles

    c. It will prevent the pressure from dropping inside the recovery storage cylinder or vessel

    d. It will prevent the water from freezing inside the tubing bundle

14. When changing out a minor component such as high side float valve that meters refrigerant to the evaporator on some types of centrifugal air conditioners which of the following procedures would be the correct way to accomplish this task? #46

    a. Pressurize the system with controlled hot water to atmospheric pressure before opening it

    b. Pressurize the system with dry air to atmospheric pressure before opening it

    c. Evacuate the system down to atmospheric pressure before opening it

    d. Recover all the refrigerant in the system and pull it down to not less than 28" Hg

15. The 15 November l993 date established by the EPA for recovery type equipment states that before that date recovery equipment was required to pull 25" Hg of vacuum before major repairs could be made on centrifugal air conditioners. What is the requirement for equipment manufactured after 15 November l993? #viii, 44, 45

    a. 25" Hg   b. 27" Hg

    c. 28" Hg   d. 25mm Absolute

16. Where does the factory installed purge unit on a centrifugal air conditioner draw refrigerant from to separate the non-condensable from the refrigerant? #42

    a. From the top of the evaporator

    b. From the top of the condenser

    c. From the oil separator

    d. From the high side float chamber

17. Refrigerants 12, 22, and 502 are all code grouped Al. What code group has ASHRAE Standard 34 grouped R123? #47

    a. A2 b. A3

    c. B1 d. B2

18. During the recovery of refrigerant on a centrifugal air conditioner it is recommended that the oil heaters be energized to vaporize any refrigerant trapped in the oil. What is the recommended temperature that the oil should be heated to, to release the refrigerant? #45

    a. 90 degs. F. b. 110 degs. F

    c.130 degs. F. d. 150 degs. F.

19. During an evacuation procedure the service technician can run into the problem of moisture vapor freezing, how can this problem be over come? #43, 44, 45, 58, 62

    a. Pressurizing the system with dry nitrogen to raise the pressure above freezing and re-evacuating the system.

    b. Pressurize the system with dry nitrogen and permit the nitrogen to absorb the moisture as nitrogen is an excellent desiccant.

    c. Add heat to the outside of the appliance using heat pads, or lamps, controlled hot water if it is known that the leak is not from one of the two sets of tubing bundles in the system.

    d. All of the above are correct procedures to help remove moisture trapped inside a system whether frozen or not.

20. When pressurizing a system that was charged with R-11, a CFC type refrigerant, which of the following is the only EPA and safety approved method? #44, 52

    a. Using an inert gas

    b. Injecting hot water into the system

    c. Pressurizing with an approved HCFC refrigerant

    d. Injecting superheated dry hot steam under controlled conditions

21. Before connecting a cylinder of dry nitrogen to a system for any reason which of the following is a must for safety reasons? #62

    a. Always wear protective clothing

    b. Inspect your butyl lined gloves for leaks before putting them on

    c. Install a pressure regulator designed for nitrogen cylinders

    d. Read the toxicity warning label and treatment instructions in case of an accident

22. Over a prolonged period of time (years) breathing refrigerant vapors, refrigerant mists will have what effect on the service technicians health? #63

    a. Heart irregularities

    b. Unconsciousness or death

    c. Brain damage and lung disorders

    d. None, Al and B1 type refrigerants are non toxic

23. When large volumes of nitrogen are required what is the proper method of regulating it? #62

    a. Install more cylinders of nitrogen

    b. Install extra regulators in a series manifold

    c. Install extra regulators in a parallel manifold

    d. Adjust the regulator to a higher pressure to increase flow

24. Besides using a pressure regulator what other device for safety reasons should be installed in the line when using dry nitrogen to pressurize, purge or blow out a system? #62

    a. A pressure relief valve

    b. A high pressure safety shut-off control

    c. None, pressure regulators have a built-in shut down device that automatically shuts down the valve if design pressures are exceeded

    d. None, all refrigeration systems are required by law to have some sort of pressure relief device installed in them somewhere to prevent explosions

25. Which of the following statements are true concerning used refrigerant oils? #68

a. Used refrigerant oils are not considered contaminated unless mixed with other oils

b. Used refrigerant oils that contain acids must be processed separately from other refrigerant oils

c. Used refrigerant oils must not be used for heating oil unless certified to be refrigerant free

d. The answers a, b, and c are all true and correct statements and conform to EPA regulations

ANSWERS
FOR PRETEST SAMPLE QUESTIONS
DOD EPA UNIVERSAL TECHNICIAN CERTIFICATION

CORE		TYPE I		TYPE II		TYPE III	
1	b	1	d	1	b	1	c
2	c	2	b	2	d	2	a
3	d	3	a	3	b	3	b
4	a	4	d	4	b	4	a
5	d	5	d	5	a	5	c
6	b	6	b	6	c	6	c
7	b	7	a	7	a	7	a
8	c	8	c	8	b	8	c
9	b	9	d	9	a	9	a
10	b	10	a	10	b	10	a
11	c	11	b	11	c	11	b
12	d	12	d	12	b	12	a
13	c	13	a	13	a	13	d
14	d	14	c	14	c	14	a
15	d	15	b	15	a	15	d
16	a	16	d	16	b	16	b
17	d	17	d	17	a	17	c
18	c	18	d	18	d	18	c
19	a	19	a	19	d	19	d
20	b	20	d	20	b	20	b
21	d	21	c	21	b	21	c
22	d	22	a	22	d	22	c
23	b	23	d	23	a	23	c
24	c	24	c	24	c	24	a
25	d	25	c	25	d	25	d

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AUTHORIZED REFERENCE FOR USE DURING CFC/HCFC CERTEST
COMPILED BY THE 366 TRS

Temp F	*R-11*	*R-12*	*R-22*	*R-500*	*R-502*
-100	29.8" Hg	27" Hg	25.0" Hg	26.4" Hg	23.3" Hg
-90	29.7" Hg	25.7" Hg	23.0" Hg	24.9" Hg	20.6" Hg
-80	29.6" Hg	25.7" Hg	20.2" Hg	22.9" Hg	17.2" Hg
-70	29.4" Hg	24.1" Hg	16.6" Hg	20.3" Hg	12.8" Hg
-60	29.2" Hg	21.8" Hg	12.0" Hg	17.0" Hg	7.2" Hg
-50	28.9" Hg	19.0" Hg	6.2" Hg	12.8" Hg	0.2" Hg
-40	28.4" Hg	11.0" Hg	**0.5 PSIG**	7.6" Hg	**4.1 PSIG**
-35	28.1" Hg	8.4" Hg	**2.6 PSIG**	4.6" Hg	**6.5 PSIG**
-30	27.8" Hg	5.4" Hg	**4.9 PSIG**	1.2" Hg	**9.2 PSIG**
-25	27.4" Hg	2.3" Hg	**7.4 PSIG**	**1.2 PSIG**	**12.1 PSIG**
-20	27.0" Hg	**.6 PSIG**	**10.2 PSIG**	**3.2 PSIG**	**15.3 PSIG**
-15	26.5" Hg	**2.4 PSIG**	**13.2 PSIG**	**5.4 PSIG**	**18.8 PSIG**
-10	26.0" Hg	**4.4 PSIG**	**16.4 PSIG**	**7.8 PSIG**	**22.6 PSIG**
-5	25.4" Hg	**6.7 PSIG**	**20.1 PSIG**	**10.4 PSIG**	**26.7 PSIG**
0	24.7" Hg	**9.2 PSIG**	**24.0 PSIG**	**13.3 PSIG**	**31.1 PSIG**
+5	23.9" Hg	**11.8 PSIG**	**28.2 PSIG**	**16.4 PSIG**	**35.9 PSIG**
+10	23.1" Hg	**14.6 PSIG**	**32.8 PSIG**	**19.7 PSIG**	**41.0 PSIG**
+15	22.1" Hg	**17.7 PSIG**	**37.7 PSIG**	**23.3 PSIG**	**46.5 PSIG**
+20	21.1" Hg	**21.0 PSIG**	**43.0 PSIG**	**27.2 PSIG**	**52.4 PSIG**
+25	19.9" Hg	**24.6 PSIG**	**48.8 PSIG**	**31.4 PSIG**	**58.8 PSIG**
+30	18.6" Hg	**28.4 PSIG**	**54.9 PSIG**	**36.0 PSIG**	**65.6 PSIG**
+35	17.2" Hg	**32.6 PSIG**	**61.4 PSIG**	**40.8 PSIG**	**72.8 PSIG**
+40	15.6" Hg	**37.0 PSIG**	**68.5 PSIG**	**46.0 PSIG**	**80.5 PSIG**
+45	13.9" Hg	**41.7 PSIG**	**76.0 PSIG**	**51.6 PSIG**	**88.7 PSIG**
+50	12.0" Hg	**46.7 PSIG**	**84.0 PSIG**	**57.5 PSIG**	**97.4 PSIG**
+55	10.0" Hg	**52.1 PSIG**	**92.6 PSIG**	**63.9 PSIG**	**106.6 PSIG**
+60	7.8" Hg	**57.7 PSIG**	**101.6 PSIG**	**70.6 PSIG**	**116.4 PSIG**
+65	5.4" Hg	**63.8 PSIG**	**111.2 PSIG**	**77.8 PSIG**	**126.7 PSIG**
+70	2.8" Hg	**70.2 PSIG**	**121.4 PSIG**	**85.3 PSIG**	**137.6 PSIG**
+75	**0 PSIG**	**77.0 PSIG**	**132.2 PSIG**	**93.4 PSIG**	**149.1 PSIG**
+80	**1.5 PSIG**	**84.2 PSIG**	**143.6 PSIG**	**101.9 PSIG**	**161.2 PSIG**
+85	**3.2 PSIG**	**91.8 PSIG**	**155.7 PSIG**	**111.0 PSIG**	**174.0 PSIG**
+90	**4.9 PSIG**	**99.8 PSIG**	**168.4 PSIG**	**120.4 PSIG**	**187.4 PSIG**
+95	**6.8 PSIG**	**108.2 PSIG**	**181.8 PSIG**	**130.5 PSIG**	**201.4 PSIG**
+100	**8.8 PSIG**	**117.2 PSIG**	**195.9 PSIG**	**141.1 PSIG**	**216.2 PSIG**
+105	**10.9 PSIG**	**126.6 PSIG**	**210.7 PSIG**	**152.2 PSIG**	**231.7 PSIG**
+110	**13.1 PSIG**	**136.4 PSIG**	**226.4 PSIG**	**164.0 PSIG**	**247.9 PSIG**
+115	**15.6 PSIG**	**146.8 PSIG**	**242.7 PSIG**	**176.3 PSIG**	**264.1 PSIG**
+120	**18.3 PSIG**	**157.7 PSIG**	**259.9 PSIG**	**189.2 PSIG**	**282.7 PSIG**
+125	**21.0 PSIG**	**169.1 PSIG**	**277.9 PSIG**	**202.8 PSIG**	**301.4 PSIG**
+130	**24.0 PSIG**	**181.0 PSIG**	**296.8 PSIG**	**217.0 PSIG**	**320.8 PSIG**
+135	**27.1 PSIG**	**193.5 PSIG**	**316.6 PSIG**	**231.8 PSIG**	**341.2 PSIG**
+140	**30.4 PSIG**	**206.6 PSIG**	**337.2 PSIG**	**247.4 PSIG**	**362.6 PSIG**
+145	**34.0 PSIG**	**220.3 PSIG**	**358.9 PSIG**	**263.7 PSIG**	**385.0 PSIG**
+150	**37.7 PSIG**	**234.6 PSIG**	**381.5 PSIG**	**280.7 PSIG**	**408.4 PSIG**

" Hg indicates inches of Mercury (below 0 PSIG)

Temp F	*R-123*	*R-124*	*R-125*	*R-134a*	*R-143a*
-100	29.9" Hg	29.2" Hg	24.4" Hg	27.8" Hg	
-90	29.8" Hg	28.8" Hg	21.7" Hg	26.9" Hg	
-80	29.7" Hg	28.2" Hg	18.1" Hg	25.6" Hg	
-70	29.6" Hg	27.4" Hg	13.3" Hg	23.8" Hg	
-60	29.5" Hg	26.3" Hg	7.1" Hg	21.5" Hg	
-50	29.2" Hg	24.8" Hg	**0.3 PSIG**	18.5" Hg	
-40	28.9" Hg	22.8" Hg	**4.9 PSIG**	14.7" Hg	**12.7 PSIG**
-30	28.5" Hg	20.2" Hg	**10.6 PSIG**	9.8" Hg	**19.1 PSIG**
-20	27.8" Hg	16.9" Hg	**17.4 PSIG**	3.8" Hg	**26.6 PSIG**
-10	27.0" Hg	12.7" Hg	**25.6 PSIG**	**1.8 PSIG**	**35.4 PSIG**
0	26.0" Hg	7.6" Hg	**35.1 PSIG**	**6.3 PSIG**	**45.7 PSIG**
+10	24.7" Hg	1.4" Hg	**46.3 PSIG**	**11.6 PSIG**	**57.5 PSIG**
+20	23.0" Hg	**3.0 PSIG**	**59.2 PSIG**	**18.0 PSIG**	**71.1 PSIG**
+30	20.8" Hg	**7.5 PSIG**	**74.1 PSIG**	**25.6 PSIG**	**86.7 PSIG**
+40	18.2" Hg	**12.7 PSIG**	**91.2 PSIG**	**34.5 PSIG**	**104.4 PSIG**
+50	15.0" Hg	**18.8 PSIG**	**110.6 PSIG**	**44.9 PSIG**	**124.5 PSIG**
+60	11.2" Hg	**25.9 PSIG**	**132.8 PSIG**	**56.9 PSIG**	**147.1 PSIG**
+70	6.6" Hg	**34.1 PSIG**	**157.8 PSIG**	**70.7 PSIG**	**201.1 PSIG**
+80	1.1" Hg	**43.5 PSIG**	**186 PSIG**	**86.4 PSIG**	**232.9 PSIG**
+90	**2.6 PSIG**	**54.1 PSIG**	**217.5 PSIG**	**104.2 PSIG**	**268.4 PSIG**
+100	**6.3 PSIG**	**66.2 PSIG**	**252.7 PSIG**	**124.3 PSIG**	**307.7 PSIG**
+110	**10.5 PSIG**	**79.7 PSIG**	**291.6 PSIG**	**146.8 PSIG**	**351.3 PSIG**
+120	**15.4 PSIG**	**94.9 PSIG**	**334.3 PSIG**	**171.9 PSIG**	**399.4 PSIG**
+130	**21.0 PSIG**	**111.7 PSIG**	**380.3 PSIG**	**199.8 PSIG**	**452.4 PSIG**
+140	**27.3 PSIG**	**130.4 PSIG**	**430.2 PSIG**	**230.5 PSIG**	
+150	**34.5 PSIG**	**151.0 PSIG**	**482.1 PSIG**	**264.4 PSIG**	
+160	**42.5 PSIG**	**173.6 PSIG**		**301.5 PSIG**	
+170	**51.5 PSIG**	**198.4 PSIG**		**342.0 PSIG**	
+180	**61.4 PSIG**	**225.6 PSIG**		**385.9 PSIG**	
+190	**72.5 PSIG**	**255.1 PSIG**		**433.6 PSIG**	
+200	**84.7 PSIG**	**287.3 PSIG**		**485.0 PSIG**	
+210	**98.1 PSIG**	**322.1 PSIG**		**540.3 PSIG**	
+220	**112.8 PSIG**	**359.9 PSIG**			
+230	**128.9 PSIG**	**400.6 PSIG**			
+240	**146.3 PSIG**	**444.5 PSIG**			
+250	**165.3 PSIG**	**491.8 PSIG**			
+260	**185.8 PSIG**				
+270	**207.9 PSIG**				
+280	**231.8 PSIG**				
+290	**257.5 PSIG**				
+300	**285.0 PSIG**				

" Hg indicates Inches of Mercury (below 0 PSIG)

REMOVE PRESSURE/TEMPERATURE CHARTS TO COMPLETE TEST QUESTIONS AND THE SCRATCH SHEET PROVIDED TO BE USED FOR COMPUTATIONS

SCRATCH SHEET

When completing each certification test the computer will give a summary prior to moving on to the next test. Jot down the letter codes where you may need additional study before moving to the next test. See pages 22,23.